ELECTRICAL REVIEW

THE PIONEER ELECTRICAL WEEKLY OF AMERICA

VOL. LII. No. 24. NEW YORK, SATURDAY, JUNE 13, 1908. ISSUED WEEKLY

CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . VICE-PRESIDENT
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . MANAGING EDITOR

NEW YORK
PUBLISHING OFFICE . . . . . 13-21 PARK ROW
CHICAGO
WESTERN OFFICE . . . . . FISHER BUILDING
BOSTON
NEW ENGLAND OFFICE . . . . . 95 MILK STREET
LONDON
EUROPEAN OFFICE, HENRY W. HALL, Manager, 42 OLD BROAD STREET, E. C.

TELEPHONE AND CABLE
TELEPHONE "21 Cortland." Private exchange to all Departments.
REGISTERED CABLE ADDRESS: "Electview," New York.

SUBSCRIPTIONS

One Year, United States	$3.00
One Year, Canada	4.00
One Year, Foreign Countries	6.00
Single Copy, 10 cents. Back numbers, beyond one month, each	.25

ADVERTISING

CHANGES for advertisements should be in this office by *Friday noon* for the following week's issue.
NEW ADVERTISEMENTS should be in the office not later than *Monday noon* to assure publication in that week's issue.

Published weekly by the ELECTRICAL REVIEW PUBLISHING COMPANY, 13 Park Row, New York. Charles W. Price, president and treasurer; Stephen H. Goddard, vice-president; H. S. Tuthill, secretary.

Entered at the Post Office at New York as second-class matter under the Act of March 3, 1879.

CONTENTS

EDITORIAL:
Some Needed Electrical Methods . . . 931
Asymmetrical Conduction in a Vacuum Tube . . . 932
Advantages of Electric Power in Rolling Mills . . . 932
Wireless Transmission of Pictures . . . 933
Volatilization of Metals in Vacuum Tubes . . . 933
The 27,000-Volt Transmission System of the Obermatt Power Plant in Switzerland, by Frank Koester . . . 934
Gas Engine Practice . . . 936
American Institute of Electrical Engineers' Convention . . . 937
Annual Convention of the Society of Wireless Telegraph Engineers . . . 937
Distribution in Suburban Districts, by George H. Lukes . . . 938
Electrical Men Enjoy Planked Shad and Waffles . . . 941
North Dakota Independent Telephone Association . . . 941
Potentiometer Design, by Joseph H. Hart . . . 942
German Street Railway Statistics . . . 943
The Society for the Promotion of Engineering Education . . . 943
Annual Meeting of the New York Electrical Society . . . 943
The Chemical Education of the Engineer, by William H. Ellis . . . 944
New Use for Silicon . . . 945
Rate Change for Edison Electric Illuminating Company of Boston . . . 945
American Society of Mechanical Engineers . . . 946
BOOK REVIEWS . . . 946
Performance of the Storage Battery and Its Relation to the Power Plant, by W. B. Gump . . . 947
National Education Association . . . 950
The Relation of the Southern Appalachian Mountains to the Development of Water-Power . . . 950
Time Limit for Westinghouse $10,000,000 Subscription Extended to June 22 . . . 950
Electrical Notes from Europe . . . 951
Electrical Notes from Great Britain . . . 952
Central Station Practice . . . 954
The Rusting of Iron . . . 955
Tungsten Lamps . . . 956
Financial Reports of Electric Companies . . . 957
The American Institute of Chemical Engineers . . . 957
Civil Service Examinations for New York State and County Service . . . 957
Recent Progress in Tungsten Metallic-Filament Lamps . . . 958
The Rectification Effect in a Vacuum Tube . . . 963
Reviews of Current Engineering and Scientific Literature . . . 964
INDUSTRIAL SECTION:
The Willis "Straight Line" Meter . . . 966
Motor-Driven Eraser . . . 966
Boring and Turning Mill . . . 967
New Adapter for Tungsten Lamps . . . 967
Holophane and Imitation Glassware—An Interesting Comparison. 968
The Purchase of the Lafayette Electrical Manufacturing Company. 968
Brilliant Electric Lamps—A Correction . . . 968
The Greatest Roof Sign in the World, by Benjamin Wall . . . 969
To Exploit German Arc Lamps . . . 969
United States Civil Service Examination . . . 969
CURRENT ELECTRICAL NEWS . . . 970
DIRECTORY OF ELECTRICAL AND ALLIED ENGINEERING AND SCIENTIFIC SOCIETIES . . . 976
RECORD OF ELECTRICAL PATENTS . . . 977

Copyright, 1908, by Electrical Review Publishing Co.

SOME NEEDED ELECTRICAL METHODS.

The various electrical arts have advanced so rapidly and solved so many difficult problems that many engineers now turn instinctively to their electrical brother to help them when they are in trouble. There are, of course, in every industry many unsolved problems and many opportunities to improve on methods now considered good practice. Frequently some application of electricity would furnish the means for development if only the one who feels the need were aware of the means by which it might be supplied. Other times the way out of the difficulty is not so apparent. It frequently will be found that electrical methods offer the best promise of overcoming the difficulty. In a recent address on "Some Unsolved Problems in Metal Mining," delivered before the Institution of Civil Engineers, of Great Britain, Professor Henry Louis discussed certain needs of the mining industry, some of which call for improved methods, and others for entirely new ones. Among these were a number of problems which seemed to offer opportunities for the electrical engineer.

One of the most important of these problems is that presented by the mine itself; for, as Professor Louis said, every mine is itself an unsolved problem until it is finally abandoned as exhausted, and even then there is a possibility that a little more work may give it a renewed lease of life. What, therefore, would be most welcome to the mining engineer would be some reliable method of locating minerals and determining with some approximation their extent and position. For certain of the magnetic ores the mining compass is useful, but its value is very limited, and it is employed merely because there is nothing better. It gives no idea of the value of the deposit. From time to time various electrical methods have been proposed, one of which at least showed promise of good work, but even this has dropped out of sight in the past year or so. The problem to be solved is, of course, most complex, but it is not impossible that some electrical method may be devised which will enable us to draw some conclusions regarding underground mineral deposits.

Another problem which might be solved by electrical means is not unrelated to the one just touched upon, but if the proper solution be found, it would be valuable for work in the mine, as well as for locating it. The only method at present of obtaining any reliable information of underground bodies is by means of the diamond drill, which brings up a core of the rocks through which it passes; but, unfortunately, the diamonds used for this purpose are scarce and expensive, and

there is no artificial substitute for them as yet. Here is an opportunity to utilize the electric furnace to prepare a tough material for the drills which must be considerably harder than quartz and not too expensive. A material of this kind would not only lessen the cost of drilling bore holes, but prove most useful in working the mine.

A secondary problem involved in the drilling of deep bore holes is the determination of the angle which these make with the vertical, as they nearly always deviate from the direction in which they are started. The compass needle has heretofore been the main reliance in this matter, but it is far from satisfactory.

Still another problem which is, according to Professor Louis, as yet to be solved, is the improvement of the electric drill. Percussion drills are still largely used for piercing hard materials, but for reciprocating motion the compressed-air type is preferred by many to the purely electrical drill. However, the efficiency and convenience of the electrical transmission system, as compared with compressed air, often more than balances the advantages thought to be possessed by the air drill. Hence we have the combined system of electrical transmission for furnishing power to a small motor driving a pulsator, which in turn drives a drill. Professor Louis, however, does not think that this is the proper solution. For coal-mining the rotary drill has largely displaced the reciprocating drill, and he thinks that the same change will follow in mines where the material to be drilled is harder than coal when once the problem of the rotary drill is solved. Here the electrical drive will come in most advantageously, but can not be applied until a suitable material for the bits is at hand. The advantages gained from this change are several and important. One of them will be the improved condition with respect to the health of the miners, as it is said that the reciprocating drill produces a sharp, cutting dust which leads to that dread disease, miners' phthisis.

Another problem to be solved is the production of a steel of high tensile strength for the hoisting ropes. The best ropes made to-day, at a depth of 9,333 feet reach their limiting static stress, with a factor safety of six, due to the weight of the rope alone. What is needed for very deep mines is a steel or alloy having a much greater tenacity. Might not the electric furnace be found useful here, as it already has proved invaluable in the preparation of special, high-grade metals for other purposes?

Various other problems before the mining engineer are touched upon by Professor Louis, in some of which electrical methods are already doing good service. This is particularly true with respect to underground haulage, where the electric motor is largely used, for lighting, for ventilating and for pumping. The high-pressure motor-driven rotary pumps are doing invaluable service in the last field, and the ease with which they may be installed or moved from point to point, following the water, is a decided advantage. From what has been said it is evident that for many mining purposes, if not all, electric power or electrical methods are carrying the day.

ASYMMETRICAL CONDUCTION IN A VACUUM TUBE.

An interesting phenomenon has been noticed by Professor H. A. Perkins when an exhausted tube is exposed to the action of a metallic ring charged by an alternating current of comparatively low potential and frequency. He found that the action of the ring set up a direct current through the tube, the direction of the flow depending upon the position of the ring, and the intensity of the current depending upon the potential of the ring as well as its position. In fact, it was found that the tube thus equipped became a rectifier which could be controlled more or less by simply shifting the ring along the tube from one point to another.

A theory of this asymmetrical action of the tube is given in the June issue of the *American Journal of Science,* where the effect is described. By merely assuming an ionizing action of the ring and a different rate of migration of the ions due to the different potential gradients along the two ends of the tube, and also a difference in conductivity, or rather "convectivity," at different parts of the tube, due to the presence near the ring of more ions than exist at the extreme ends, analytical equations are deduced, which, when plotted, give curves closely resembling those found experimentally. This seems to be a good confirmation of the theory, which is, of course, in agreement with modern ideas of the passage of electricity through gases.

At the present moment no application of this phenomenon occurs to us, but it would seem that a simple device of this kind, which produces a direct current from an alternating one without employing moving parts, and which gives control both over the direction and intensity of this current, would find some use. It would be interesting to learn something more of the capabilities of the apparatus, its efficiency, and whether there is any probability of obtaining comparatively large direct currents by this means.

ADVANTAGES OF ELECTRIC POWER IN ROLLING MILLS.

It has again and again been pointed out that two of the most important advantages of the electric drive are its convenience and the increased output of the electrically driven plant as compared with one driven in some older way. These advantages, particularly the latter, are, in most cases, far more important than the other factors which enter into the problem, and in many cases justify a considerable capital outlay. It was, therefore, not at all surprising—in fact, was only to be expected—that the same result should follow from the introduction of electric power in rolling mills. That this has been the case seems to be pretty conclusively shown in a paper presented at the recent meeting of the Iron and Steel Institute, London, by Mr. Andrew Lamberton. In discussing improvements in plate-rolling mills, Mr. Lamberton said that the remarkable progress of the past few years has been principally in the direction of increasing the output of the mills, so that mills of to-day, as compared with those of twenty years ago, have double, and in

some cases three times, the output. The explanation is given in the following quotation:

"This result has largely been achieved by improvements effected in the details of the accessory machinery throughout the mill plant. Electrically driven roller tables, which are now fitted at both sides of roughing and finishing mills; electrically driven transfer gears, and the very efficient drafting arrangements, also operated by electric motors, have greatly reduced the time occupied in the operations of handling and rolling plates. Improvements have also been made in slab-heating furnaces, which have been increased in capacity and in power to heat rapidly, and, served, as they are now, by electric charging machines, have reduced considerably the time required for charging, heating and withdrawing slabs for rolling mills. These improvements in detail have had the effect of increasing the output capacity, but the most important improvements have been effected in rolling mills themselves, which have been greatly strengthened in all their parts, and their speed accelerated threefold."

In driving the rolls themselves, certain electrical methods have been giving good results. They have shown a high efficiency with a large output. Recently it has been said that a properly designed steam drive has some advantages over the electric, but if this be true, it is surprising that rolling-mill engineers, who are always striving for increased capacity, did not appreciate the fact until it was demonstrated by the installation of a few electrical drives.

WIRELESS TRANSMISSION OF PICTURES.

Some astonishment has been expressed at the success which has been secured by Mr. H. Knudsen in transmitting pictures by means of wireless telegraphy. A brief description of the apparatus used for this purpose was given in the ELECTRICAL REVIEW for May 23. Although in a somewhat experimental condition, it still gives fairly satisfactory results. This inventor also asserts that by his system it will be possible to set type if any one so desire.

To the uninitiated these performances seem to be truly wonderful, but when analyzed it will be found that the method is really simple. The only marvelous part is that we can produce a disturbance at one point and thereby effect a minute corresponding disturbance at another point without any intervening conductor. In fact, if one wishes to go to the bottom of the matter, the interposition of a conductor does not really simplify the matter much for the physicist, though sixty years of practical telegraphy has made this process very commonplace, and hence simple to the lay mind.

Knudsen's system, in brief, consists simply in an application of the Morse method of telegraphing. He transmits, by a mechanical device, a series of dots following one another in the proper sequence. Dots close together produce a dark line; further apart, a light line ; and the entire picture is built up in this way just as a mosaic is formed of bits of colored porcelain.

By the same process it is not a difficult matter to produce a large variety of mechanical effects, such, for example, as the operation of a type-setting machine. In all such processes the greatest difficulty is in running two devices entirely disconnected, in synchronism; but by stopping these devices after every revolution, or stroke, and starting them again simultaneously, this difficulty is overcome. A somewhat serious obstacle to the general introduction of such systems, either for transmitting pictures or for other purposes, is that they require a considerable time in order to effect the entire operation. Knudsen's method is, of course, applicable to the transmission over wire by the simple introduction of two clock-driven mechanisms, which automatically stop after each stroke or revolution, and are started again simultaneously.

VOLATILIZATION OF METALS IN VACUUM TUBES.

One of the many interesting phenomena observed in an exhausted tube, when an electrical discharge takes place, is the volatilization of metals which may be brought about if the positive carriers of electricity are focussed upon them. This action has generally been assumed to be the result simply of the intense heat due to the bombardment by the flying particles, which are not only moving at a high velocity, but are believed to have considerable mass, comparable, at least, to that of the hydrogen atom. This view is, however, not accepted by all, and among those who dissent from it is Professor V. Kohlschütter. The latter, in conjunction with Messrs. R. Müller and T. Goldschmidt, has studied this effect carefully, and has come to the conclusion that the volatilization is largely a chemical effect, and due to a chemical reaction brought about between residual gas in the tube and the metal of the cathode by the liberation of energy which takes place when the positively charged particles strike the metal. These compounds are supposed to be endothermous, and it is said that they may be collected and decomposed, and thus cause a metallic deposit.

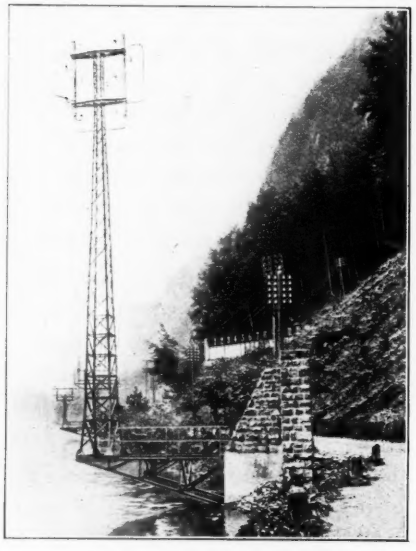
In support of this theory, it is pointed out that the order in which the metals are attacked is that of their electrochemical equivalents, while the gases appear to arrange themselves, as regards their capacity for combining with the electrodes, according to their atomic weights. These laws are not followed without exception, as cadmium does not appear to fall into the proper place. Another fact explainable by the proposed theory is the fall in gaseous pressure which takes place upon the passage of the discharge. It has been suggested that the occlusion of the gases by the metals would have something to do with this diminution in pressure, as well as with the volatilization of the metals on account of the heat evolved, but experiments by Professor Kohlschütter seem to indicate that this is not so. In fact, he found apparently that a mica plate placed over the cathode suffered electrolysis, due to the discharge which was directed against it.

This theory of the formation of entirely new chemical compounds, due to the large amount of energy liberated at the surface of the metal when bombarded by the positive carriers, opens an interesting field of research. If, as is asserted, the inert gases, argon and helium, actually enter into combination with various metals under these conditions, it is not unlikely that the same means may be used to bring about other new chemical reactions and possibly lead to a considerable extension of our knowledge of chemical facts.

The 27,000-Volt Transmission System of the Obermatt Power Plant in Switzerland.

By Frank Koester.

THE power plant at Obermatt, Switzerland,[1] for supplying current for various purposes, manufacturing, railways and lighting, to Lucerne and the vicinity, was built about two years ago, the transmission lines having been recently completed. The plant is located about seventeen miles from Lucerne and utilizes the water, by means of four 2,000-horse-power Pelton wheels, of a natural collecting basin supplied by streams and glaciers of the "Engelberg," under a head of 1,023 feet. There are also installed two 150-horse-power exciter units and



27,000-Volt Transmission Line, Showing Cantilever Construction for Supporting the Lattice Towers.

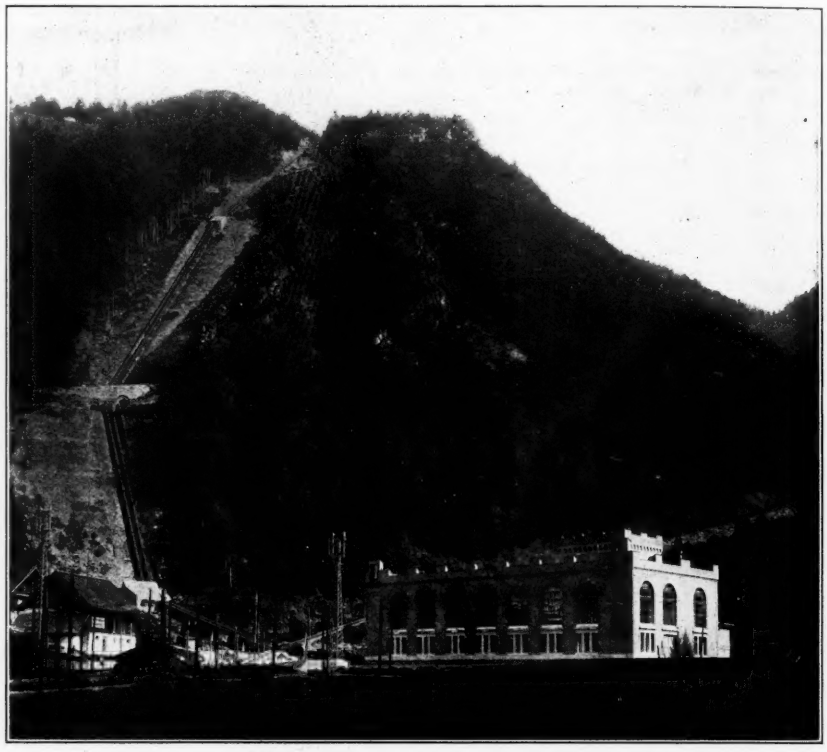
one 600-horse-power turbo-generator. Space is provided for two more 2,000-horse-power Pelton wheels and one more exciter unit.

As the current is used both for lighting and power purposes, two distinct bus-bar systems have been installed, current of 6,000 volts, three-phase, fifty-two cycles being generated and stepped up to 27,000 volts, for which a very elaborate transformer equipment has been installed. The step-up transformers are located in an annex alongside of the generating room and are contained in separate fireproof compartments; the switching room, which is three stories, being between the transformer annex and the generating room. The 6,000-volt generator oil-switches are located on the ground floor, above which are the 27,000-volt oil switches, separated by partition walls from the main operating gallery, from which the whole generating room may be overlooked. In the tower which constitutes the third floor are the outgoing feeders.

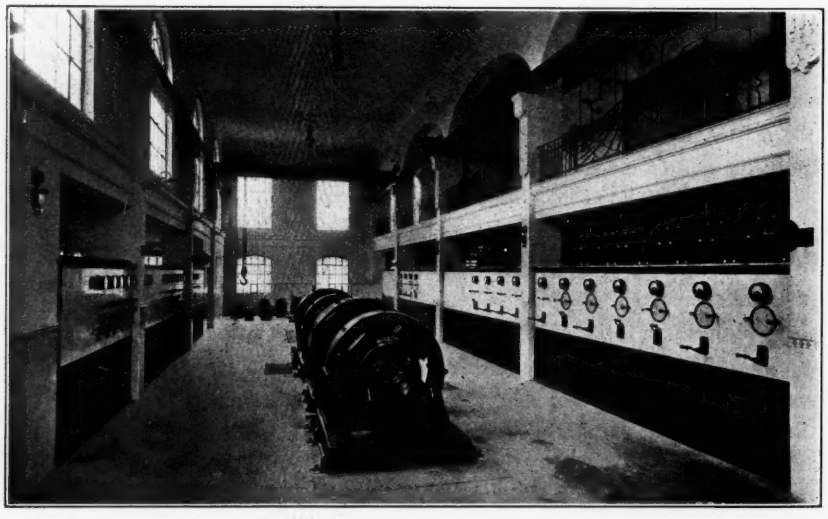
[1] For a description in detail of this hydroelectric plant see writer's article in Electrical Review, August 11, 1906.

TRANSMISSION SYSTEM.

The high-tension transmission line runs from the power plant at Obermatt through the valley of the Engelberger Aa to Stanstad, located on the Vierwaldstaetter Lake. From here it runs along the steep slopes of the Lopper Mountain *via* Her-

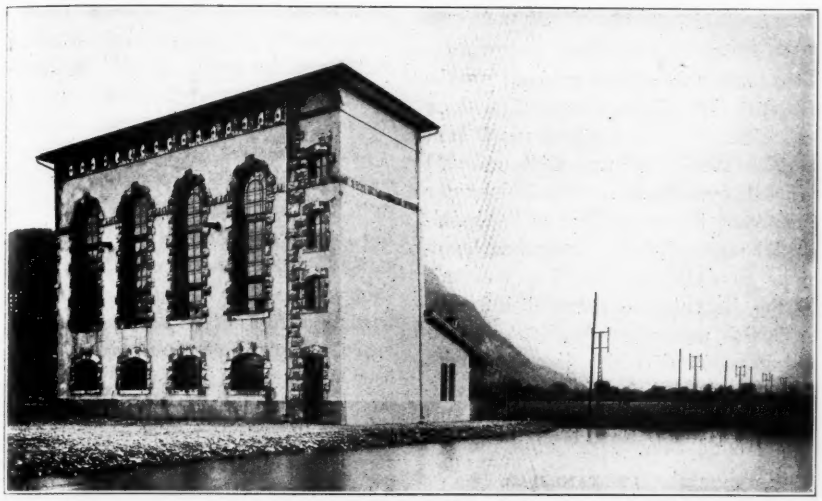


Penstock, Power Plant and Transmission Line, Hydroelectric Plant at Obermatt, Switzerland.



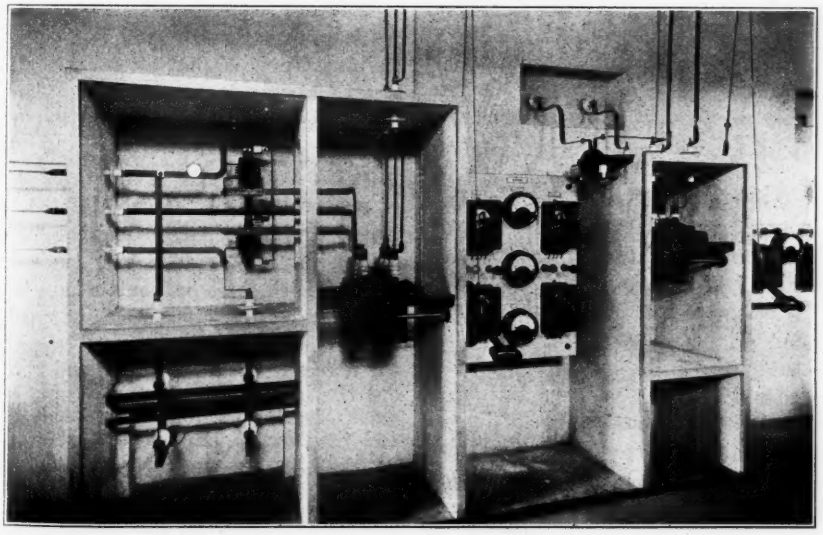
Interior of Substation at Steghof, Obermatt, Switzerland, Hydroelectric Plant.

giswil to Lucerne, for connecting to the substation at Steghof. Substations are located on the direct line at Wolfenschiessen, Stansstad, Hergiswil and Steghof. This line is 16.25 miles long and consists of nine wires, eight millimetres diameter, six of these constituting two



SUBSTATION AT STANSSTAD AND TRANSMISSION LINE, OBERMATT, SWITZERLAND, HYDROELECTRIC PLANT.

circuits necessary for light and power, the other circuit of three wires being a reserve. Between the power station and the first substation at Wolfenschiessen a circuit branches off to a small substation at Grafenort. From the substation at Stan-

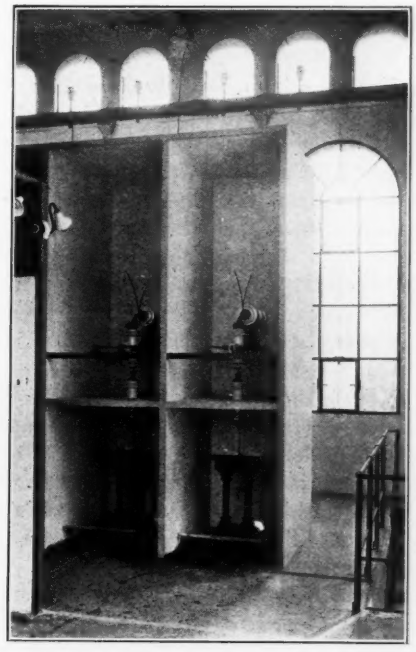


REAR OF 6,000-VOLT SWITCHBOARD FOR ONE TRANSFORMER GROUP AT THE STEGHOF SUBSTATION.

sstad a 5,000-volt line runs to a substation at Stans for light and power purposes, while another runs to Kerns to assist a power plant.

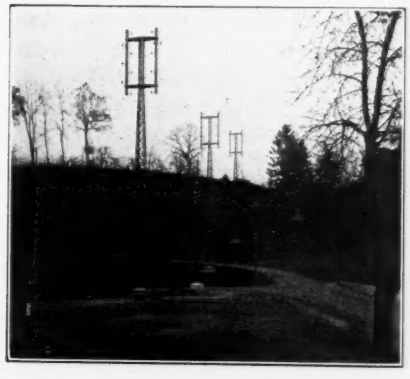
For the transmission line steel towers of lattice construction are placed at a normal distance of 170 feet apart, while in some instances the spacing is 340 feet. As the illustration shows, the tower possesses two cross-arms made up of four channel irons. Vertical oak impregnated timbers connect the lower and upper cross-arms on each side of the tower, upon each of which are mounted the insulators. These are so placed as to make the distance between the conductors thirty-nine and one-half inches. The timbers are so braced on the sides as well as at the bottom that in case of a break of the wire the likelihood of the wire's dropping to the ground is minimized. All towers are grounded by means of five-millimetre-diameter copper wires which run the entire length of the transmission line about seven feet below the lowest high-tension line. At every tenth tower the wire is connected to a copper ground plate with a surface of ten square feet. On the other side of the tower, opposite the grounding wire, is a telephone line, being a three-millimetre bronze wire.

Between the town of Stans and Hergiswil it was impracticable, owing to the steep slope of Lopper Mountain, the nar-



HORN LIGHTNING ARRESTER WITH WATER-FLOW RHEOSTATS AT STEGHOF SUBSTATION.

row road and the steep bank of the Vierwaldstaetter Lake on the opposite side of the road, to locate the towers alongside the road. Therefore the towers were carried on a cantilever extending from the



27,000-VOLT TRANSMISSION LINE, OBERMATT, SWITZERLAND, HYDROELECTRIC PLANT.

roadway above the surface of the lake. The cantilevers, which extend from eighteen to twenty feet from the road, are made of structural steel and are embedded in massive concrete blocks. Heavy, rough-faced masonry walls cover the concrete blocks for the purpose of protecting the

cantilevers against any damage which, in the springtime, might be caused by rocks falling from the mountain. Owing to the cost of these cantilevers the spacing between the towers along the lake was increased to 340 feet. The telephone and telegraph wires which already existed along this road were also factors which necessitated the construction just described.

SUBSTATION AT STEGHOF.

The operating room at the substation at Steghof is separated from the switchroom by a marble-slab construction which forms the switchboard, consisting of twenty-nine panels. Upon the first two panels are mounted the static voltmeters for testing the ground line from the bus-bars. The next two panels contain the ammeters and pilot lamps for four 24,000-volt lines. Adjoining these are the panels for light and power service for the city of Lucerne. On the back of each of these panels is a reinforced concrete cell containing the apparatus belonging to the instruments of these panels. Upon the front of each feeder panel is a small chart of the wiring diagram so that the operators may have a clear understanding of the system.

The equipment of the operating room consists at present of two 340-kilowatt, 2,650-volt, three-phase motors, directly connected to a 300-kilowatt, 575-volt direct-current generator running at 450 revolutions per minute. The motor is of the asynchronous type, provided with rotary starter, while the direct-current generator is shunt-wound. In parallel with the latter is a storage battery serving as a booster.

The switchboard for the incoming lines is located on the other side of the operating room, occupying three bays. The first three panels are provided for the motor instruments, of which two are at present equipped. The next group are the generator panels. The third group of panels, in the last bay, contain the instruments of the feeder switchboard above mentioned.

TRANSFORMER STATION AT KRIENS.

For the purpose of furnishing current from the Steghof substation to a silk mill at Kriens, three 450-kilowatt, three-phase oil transformers were installed at a substation at this mill to step down from 24,000 to 500 volts. The 24,000-volt feeder lines enter in a tower of the station through which they are carried to the basement, and are provided with horn lightning arresters connected with a water-flow rheostat. The transformers are located in the basement, while the remote-control oil switches are on the first floor. The 24,000-volt switches are arranged in concrete cells and are operated by lever, while the low-tension switches (500-volt) are operated by handwheels. The latter switches are located in the basement and are separated from the transformers by a division wall.

SUBSTATIONS AT WOLFENSCHIESSEN AND HERGISWIL.

These two substations are built on the same plan, the buildings being three-story brick. The present equipment of each substation consists of one thirty-kilowatt air-cooled transformer. The lines enter and leave on the upper floor of the building. The second floor contains such apparatus as switches, lightning arresters, etc., the lightning arresters being connected with water-flow rheostats, the circulating water of which is mixed with glycerin to prevent freezing. The transformer, 25,000 to 350 volts, is installed on the ground floor.

SUBSTATION AT STANSSTAD.

This station has at present two 250-kilowatt, 25,000-5,000-volt oil transformers. Part of the 5,000-volt current is distributed in Stanstad for light and power, and part is transmitted to Kerns to assist the power plant. Another step-down transformer, 5,000-350 volts, is used for current distributed in the vicinity of the substation.

The "Oerlikon Machinenfabrik," Switzerland, who were the designers and contractors of the electrical equipment of the power plant, also had in charge the design and erection of this transmission system.

Gas-Engine Practice.

One of the most interesting papers read at the recent convention of the National Electric Light Association was the report of the Committee on Gas Engines. Growing out of the discussion of this report the remarks by J. R. Bibbins, of the Westinghouse Machine Company, Pittsburg, Pa., brought up several points of importance to those interested in this type of prime mover. Mr. Bibbins said that one of the principal tendencies in American practice, perhaps as distinguished from European practice, has been a tendency toward the greatest possible simplicity in design, and for this reason the American engine will be found devoid of some of the refinements which will be found on European engines.

Another tendency of American practice has been toward conservatism in rating, and to this may be largely ascribed the variation which the committee notes in rating. He had a case in mind where a plant was running on a 130 British thermal unit producer gas. Whereas a card or normal rating would show a mean effective pressure of perhaps sixty pounds per square inch, the engine has actually developed as a maximum eighty-six pounds, which on the basis of indicated horse-power represents forty-three per cent above the rating, and on the basis of electrical horse-power thirty per cent above the rating.

In the question of producer plants, the committee has frankly stated the situation, and he thought he was safe in saying that American practice will never be satisfied in producer work until certain things have been changed. One of the first requisites is that we must be able to operate a plant continuously. This has been done successfully up to the present time with the water seal type, but we must have an improved method of mechanically removing the ashes. In the second place, a producer must supply its own steam or vapor. Third, we must have complete tar destruction. Fourth, we must maintain the temperature of the fuel bed at such a point as to avoid clinkers. Fifth, the producer must regulate its output automatically—that is to say, without the use of a holder. If a holder is to be used, it should be used as an equalizer of the quality of the gas and not in an attempt to store it.

Illustrating the life and low cost of maintenance he called attention to two specific cases. In one of these plants, 800 horse-power, at Bradford, Pa., the average cost of repairs during the last five years on five engines has averaged 0.89 of one per cent of the value of the engines. Another plant, in which some of the engines have been in over ten years, and in which three horizontals have been in two years, has been operating twenty-four hours a day throughout the year, and has a record to date of three and three-quarter hours' outages for all causes per month for the horizontals, and only one and three-quarter hours' outages for the verticals for the month; the cost of repairs, averaged over eleven months' service, which was the period that the report covered. including the parts supplied and renewed, was three and two-thirds per cent of the valuation of the engine, being its purchase price. This corresponds to continuous service.

At the Bessemer plant of the Carnegie Steel Company one of the blowing units has a record of 99.2 per cent of running time; that is, throughout a month, running twenty-four hours a day, and the second engine 98.3 and 98.1 per cent of the running time.

American Institute of Electrical Engineers' Convention.

The twenty-fifth annual convention of the American Institute of Electrical Engineers will be held at Atlantic City, N. J., June 29 to July 2. The headquarters will be at the Hotel Traymore. A reception and dance will be given at that hotel Monday evening, June 29, and a tea at the Atlantic City Golf Club, Tuesday afternoon. These will be the only formal functions of the convention.

The following provisional programme has been arranged for the technical sessions:

MONDAY, JUNE 29—MORNING SESSION—11 TO 12.30.

Address of welcome.

President's address, by Henry G. Stott.

"Electricity as Viewed by the Insurance Engineer. Should the American Institute of Electrical Engineers Interest Itself in Fire Protection?" by C. M. Goddard.

"Water Power Development in the National Forests. A Suggested Government Policy," by F. G. Baum.

AFTERNOON SESSION—2 TO 5.

"A Study of Multi-Office Automatic Switchboard Telephone Systems," by W. Lee Campbell.

"Wireless Telephony," by R. A. Fessenden.

"The Measurement of Rotary Speeds of Dynamo Machines by the Stroboscopic Fork," by A. E. Kennelly and S. E. Whiting.

"Notes on the Electric Heating Plant of the Biltmore Estate," by Charles E. Waddell.

TUESDAY, JUNE 30—MORNING SESSION—9.30 TO 12.30.

"Measurements of Lightning, Aluminum Lightning Arresters, Earth Resistances, Cement Resistances, and Kindred Tests," by E. E. F. Creighton.

"Tests with Arcing Grounds and Connections," by Ernst J. Berg.

"Three-Phase Power-Factor," by Austin Burt.

"Critical Study of the Taylor's Falls Lightning Records." Discussion by Percy H. Thomas of paper by J. F. Vaughan, presented at the May meeting, 1908.

"Engineering Features of the Southern Power Company's System," by J. W. Fraser.

EVENING SESSION—8 TO 10.30.

"High-Voltage Experiments at Niagara," by Ralph D. Mershon.

"Fundamental Considerations Governing the Design of Transmission-Line Structures," by D. R. Scholes.

"The Testing of High-Voltage Line Insulators," by C. E. Skinner.

WEDNESDAY, JULY 1—MORNING SESSION—9.30 TO 12.30.

"Voltage Ratio in Synchronous Converters, with Special Reference to the Split-Pole Converter," by Comfort A. Adams.

"Application of Storage Batteries to Regulation of Alternating-Current Systems," by J. Lester Woodbridge.

"A New Large Generator for Niagara Falls," by B. A. Behrend.

"Modern Developments in Single-Phase Generators," by W. L. Waters.

"Application of Fractional-Pitch Windings to Alternating-Current Generators," by Jens Bache-Wiig.

"Steam-Turbine Plant; Some Possibilities Resulting from Recent Engineering Developments," by J. R. Bibbins.

"Thirty-Day Test on Producer-Gas Power Plant: Discussion of Results in Relation to Cost of Power," by J. R. Bibbins.

AFTERNOON SESSION—2 TO 5.

"From Steam to Electricity on a Single-Track Road," by J. B. Whitehead.

"Induction Motors for Multi-Speed Service, with Particular Reference to Cascade Operation," by H. C. Specht.

"The Determination of the Economic Location of Substations in Electric Railways," by Gerard B. Werner.

"Conductor Rail Measurements," by S. B. Fortenbaugh.

THURSDAY, JULY 2—MORNING SESSION—9.30 TO 12.30.

"The General Equations of the Electric Circuit," by C. P. Steinmetz.

"Primary Standard of Light," by C. P. Steinmetz.

"An Imperfection in the Usual Statement of the Fundamental Law of Electromagnetic Induction," by Carl Hering. (With discussions by letter.)

"Graphical Treatment of the Rotating Field," by R. E. Hellmund.

"A Minimum-Work Method for the Solution of Alternating-Current Problems," by Harold Pender.

"The Relative Proportions of Copper and Iron in Alternators," by Carl J. Fechheimer.

AFTERNOON SESSION—2 TO 5.

"A New Method of Training Engineers," by M. W. Alexander.

"The Relation of the Manufacturing Company to the Technical Graduate," by D. B. Rushmore.

"The Relation of the Manufacturing Company to the Technical Graduate," by B. A. Behrend.

Annual Convention of the Society of Wireless Telegraph Engineers.

At the home of Mr. J. S. Stone, 192 Bay State Road, Boston, Mass., was held, June 1, at 8 P. M., the first annual convention of the Society of Wireless Telegraph Engineers.

This society was founded February 26, 1907, with charter officers as follows: J. S. Stone, president; Sewall Cabot, of Brookline, Mass., vice-president; G. K. Woodworth, of Brookline, Mass.; E. R. Cram and O. C. Roos, of Cambridge, Mass., managers; G. H. Clark, of Everett, secretary, and Dr. R. T. Wells, of Somerville, treasurer.

After a meeting of the board of managers the convention was called to order and the annual reports of the retiring officers were read, after which the election of officers for the ensuing year took place. J. S. Stone was elected president; E. R. Cram, vice-president; F. A. Kolster, A. P. Browne and C. C. Kolster, of Boston and Cambridge, managers; C. E. Russell, of Somerville, secretary, and Dr. R. T. Wells, treasurer.

After adjournment a collation was served and matters of interest informally discussed.

The Society of Wireless Telegraph Engineers has during the short term of its existence been a great stimulus to its members and all those associated with it. The papers presented have been of a wide range of usefulness, and have assimilated the rapidly advancing practice and theory of electric wave engineering in such a manner as to anticipate improvements in the art abroad in several cases.

There is no doubt that an organization of this kind, if thrown open to all competent engineers interested in this latest development of electrical engineering, will fill a niche in modern technical organization to the mutual advantage of both the public and the electrical profession.

It is understood that membership in the Society of Wireless Telegraph Engineers, hitherto restricted to the technical staff of the Stone Telegraph and Telephone Company, of Boston, Mass., and those associated with this company, is soon to be open to all electrical engineers whose technical interests and qualifications constitute them desirable members, irrespective of their business affiliations.

The "wireless" art is less standardized in its best exemplifications than any other branch of electrical engineering. Mutual comparison in society meetings will, it is expected, lead to a lessening of the present turmoil of conflicting development and eventually will bring about some sort of standard practice, if not construction, throughout the country. O. C. Roos.

DISTRIBUTION IN SUBURBAN DISTRICTS.[1]

BY GEORGE H. LUKES.

Distribution of electricity for commercial lighting and power in suburban districts is now almost entirely by alternating current at sixty cycles. Small direct-current installations, covering limited areas, combined with alternating current for scattered districts, are still to be found in places, but as a rule these are being done away with as fast as local conditions permit. Systems operating at 125 cycles are being rapidly changed over to sixty cycles. When suburban systems are operated independently of electric railway or direct-current lighting systems, transmission as well as distribution is at sixty cycles. When suburban systems are operated in connection with electric railway or direct-current lighting systems, the current is frequently transmitted at twenty-five cycles and converted into sixty cycles for local distribution, but the necessity for operating at two frequencies seems to be rapidly disappearing.

TRANSMISSION LINES.

The three-phase, three-wire system is ordinarily used for transmission, the voltage ranging from 6,600 to 22,000. In case either generation or local distribution is two-phase, transformers with special taps for Scott connection are provided to change from two to three-phase and *vice versa*. When both generators and distribution system are four-wire, three-phase, a four-wire, three-phase transmission system is sometimes used, the transformers being connected in star on both low and high-tension sides. This system seems to have a number of advantages for suburban use. Each phase wire may be protected by a single-pole fuse or circuit-breaker, and thus the combination operates as three single-phase transmission lines, each independent of the others. A ground on one wire results in an interruption to but one-third of the service. By means of a feeder regulator and compensator installed on each phase on the low side of the step-up transformers at the generating station, the pressure can be regulated at the substation. These features make this type of transmission a useful one for a remote substation where it is desirable to operate with the minimum attendance.

In deciding upon the transmission voltage to be used in any particular case there are a number of points to be borne in mind. A common plan is to adopt a certain voltage with the expectation of changing to a higher voltage later on. If possible, the ultimate voltage at which the system is to operate should be settled upon at the start. If this is done, equipment can be purchased that will not have to be discarded when the change is made to a higher voltage. If possible, the voltage should be the same as that used by other companies operating in adjacent towns or districts.

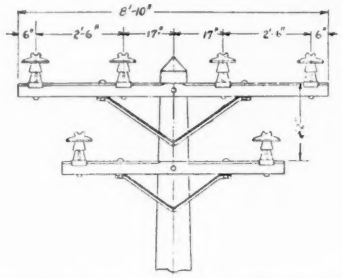


FIG. 1.—TWO THREE-PHASE TRANSMISSION LINES.

DETAILS OF LINE CONSTRUCTION.

In details of construction, suburban transmission lines differ from long-distance transmission lines. On account of their location on highways with local distribution wires on the same poles, both steel-tower construction and concrete poles are out of the question and wooden poles are the rule. The practice of placing the insulators so that the wires will be at the points of a triangle is common. Provision is frequently made for two transmission circuits on the same pole line, one on each side of the pole, as shown in Fig. 1. If the second line is not installed at first, the three wires of the first line are either placed in their permanent position on one side of the pole or mounted temporarily on the top cross-arm as shown in Fig. 2. This latter arrangement is not good electrically, on account of the wide separation between two of the wires, but is better from a construction standpoint. A four-wire, three-phase transmission line is usually arranged with the wires all on one cross-arm, but in case two circuits are operated on one pole line a better arrangement is in the form of two rectangles, one on each side of the pole, using two four-pin arms.

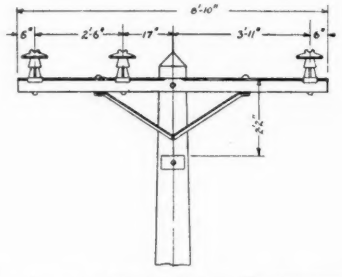


FIG. 2.—ONE THREE-PHASE TRANSMISSION LINE.

The separation between the wires of the transmission line should be made sufficient at the start for the ultimate voltage, as rebuilding a line is always attended with expense and interruption to the service. If it is necessary to carry local distributing wires on the same poles with transmission wires, the separation between the different sets of wires must be ample to allow linemen to work on the local wires while all wires are alive. Five feet is usually enough for the purpose, and this is sometimes made less at crossings where high poles are required.

Porcelain insulators are now almost universally used for transmission voltages above 6,600. It is noticeable that insulator manufacturers are now rating their insulators more conservatively than they did several years ago. For suburban work the insulator must be able to stand up for a period after being considerably damaged.

In the course of time a large suburban system is likely to have a good many miles of transmission lines, parts of which may be easily watched and patrolled and other parts quite inaccessible. The more important substations, where business warrants it, will be supplied from two sources over separate lines. The less important centres must rely on single lines. The lines must be regularly inspected, and the result of each inspection made a matter of record so that it can be shown, if necessary, in a court of law that the company has not been negligent and has used reasonable care.

SUBSTATIONS.

Unless the substation is of a temporary character, a decision as to the proper location and type requires careful consideration. In building a substation it is always wise to provide for the future. This necessitates the erection of a building somewhat larger than is required for immediate needs, so that additional electrical equipment can be installed as the business develops. As a general rule, the substation should be located as near as possible to the centre of load of the district it is to supply. The substation must be where both high and low-tension overhead lines can be brought to it with the least objection from property owners and public authorities. It should be accessible from transportation lines.

The great cost of even a moderate

[1] Abstract of a paper read before the National Electric Light Association, Chicago, Ill., May 19.

amount of up-to-date high-tension equipment usually justifies the erection of a fireproof substation building. By fireproof is meant a building with floors, walls, ceiling and roof of incombustible material. It is not necessary to carry this fireproof construction to the doors and window frames, unless the building is greatly exposed.

TRANSFORMERS.

The question of single-phase *versus* three-phase transformers has been pretty thoroughly debated during the past few years. The greater factor of safety secured by the use of three transformers instead of one in the relatively small suburban substations seems to warrant their use even at some extra cost. In the matter of air-blast and oil-insulated transformers, experience seems to indicate that for the voltages under consideration the air-blast transformer with properly insulated end turns is as reliable as the oil-insulated type. The use, however, of air-blast transformers is confined to the larger substations, where there is an operator present at all times.

Automatic high-tension oil switches, with all the appurtenances that go with them, run into money very fast, and unless a good deal of judgment is exercised in their use an excessive investment in substation electrical equipment is likely to result, particularly in the small substations. If the transmission line is controlled by automatic oil switches it is desirable to equip similarly the primary feeders or circuits. A combination of fuses on the feeders with an automatic switch on the transmission line works badly in case of a short-circuit on a feeder, on account of the time element in the fuse.

LOCAL DISTRIBUTING SYSTEMS.

Distribution for commercial lighting and power may be by single-phase, two-phase or three-phase systems, the ordinary voltage being approximately 2,200 volts.

The demand in suburban districts being principally for current for lighting and small power, a large part of the distribution is by means of single-phase feeders. In certain sections, however, power business may be obtained in units of considerable size and polyphase current must be supplied. The two-phase system has the merit of being simple, requiring but two transformers for each power customer. A four-wire, two-phase feeder may be controlled by one four-pole switch or by two double-pole switches; thus the switchboard equipment is quite flexible. Pressure regulation is very easily accomplished by installing two feeder regulators, one on each phase; power and lighting loads, either balanced or unbalanced, can thus be taken care of on the same feeder. The same amount of copper, however, is required for four-wire, two-phase as for single-phase distribution. The copper

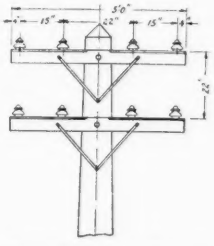


FIG. 3.—FOUR-PIN ARM CONSTRUCTION.

may be reduced from ten to twenty-five per cent by the use of the three-wire, two-phase system, but this has some disadvantages.

The four-wire, three-phase system seems to have many advantages over other systems for suburban work. In this system the generator or transformers are Y-connected, the neutral being brought out and connected to a grounded fourth bus-bar. The voltage between any phase wire and

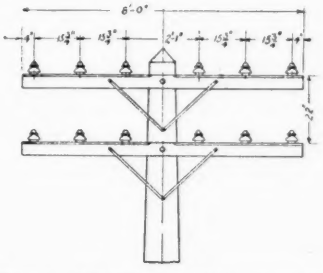


FIG. 4.—SIX-PIN ARM CONSTRUCTION.

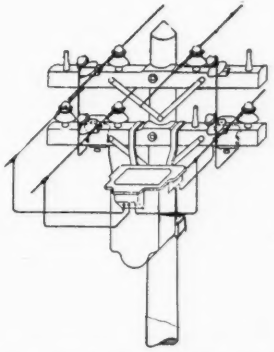


FIG. 5.—TYPICAL SINGLE-PHASE INSTALLATION.

neutral is 2,200 and between any two of the phase wires is 3,800. Single-phase feeders are supplied from neutral, any phase being controlled by double-throw switches for balancing. Districts in which the load consists of both power and lighting are supplied from four-wire feeders, which run to centres of distribution from which radiate two-wire, single-phase mains for lighting and three or four-wire, three-phase mains for power. If the load is mostly lighting the feeder may be three-wire, consisting of two-phase wires and neutral. In this case but one feeder regulator is needed, the extra phase wire being used for power only. Power in large units is supplied from three standard transformers, connected with primaries in star and secondaries in delta. Small three-phase power installations may be supplied from two-phase wires and neutral by two standard transformers in open delta. The system requires but one-third the copper necessary for single-phase or four-wire, two-phase at 2,200 volts and about forty-four per cent of that required for a three-wire, three-phase system operating at 2,200 volts under equivalent conditions.

SECONDARY DISTRIBUTION.

Secondary distribution for lighting is almost universally from three-wire secondary mains or buses at approximately 110-220 volts, customers being supplied at 110 volts for installations up to twenty or thirty lights and at 110-220 volts for larger installations. On account of the scattered nature of the business in the suburbs, a considerable number of customers are necessarily supplied from individual transformers. Much may be done, however, in the way of installing secondary buses, especially in the more thickly populated districts.

Careful attention must be given to the matter of balancing the load on long three-wire secondaries. The number of lights connected to each side may be nearly equal, but tests often show loads largely out of balance. Periodical tests with a portable cable-testing current transformer and ammeter are necessary in order to avoid trouble from this source. Distribution at 220-440 volts has been resorted to by some suburban companies in order to be able to group a larger number of customers on one transformer and thus reduce distribution losses. This scheme has been somewhat burdensome on the customers, on account of the low efficiency of the 220-volt lamps, and has become even more unsatisfactory since the metallic-filament lamps have been placed upon the market, as they are not made at all in the higher voltages.

OVERHEAD CONSTRUCTION.

In general, overhead work in the suburbs is similar to overhead work in the cities, except that on account of the

smaller number of wires a lighter type of construction is allowable. Four-pin arm construction, as shown in Fig. 3, although rarely used in the city, is well adapted for use in the outlying suburban districts. Six-pin arm construction, as shown in Fig. 4, is used for the heavier lines in the thickly settled portions near stations and substations, and might be regarded as standard construction for suburban districts. Eight-pin arm construction is not recommended for use in suburban distribution except in special cases. In the city, poles of shorter length than thirty-five feet are very rarely used. In the suburbs, thirty-foot poles are largely used and twenty-five-foot poles may be used in special cases. It would seem that efforts should be made by the electric lighting companies to provide for the future by purchasing standing poles. Such a plan could hardly be carried out by the companies acting individually, but might be quite possible if a number acted in concert.

ARRANGEMENT OF WIRES ON POLES.

Wires carrying the highest voltage should be on the upper cross-arms. Feeders and circuits to remote points should also be on the upper cross-arms, where they will not be disturbed. Primaries and street-lighting circuits for local use should be on the lower arms, where taps and transformer connections can be conveniently made. Secondary wires should be on the lowest arm by themselves. The necessity for the last rule has been questioned, but if adhered to it undoubtedly makes service and trouble-work safer, as it is sometimes difficult to distinguish between a three-phase primary and a three-wire secondary.

The additional safety to life secured by grounding the neutral of three-wire secondaries is now fully appreciated by every one and is recommended by the underwriters. Various methods of grounding the neutral have been used in the past. The most practical method is to drive a galvanized gas pipe into the earth at the foot of the pole. The ground wire is brought down the pole in wooden molding and connected to the ground pipe, which is also sometimes protected above the surface of the ground by a larger wooden molding. The problem of making a permanent joint between the ground wire and pipe has been a bothersome one. Soldered joints and plugs have been tried with indifferent success. The ground cap devised by the engineers of the Commonwealth Edison Company seems to have solved the problem. This consists of a malleable galvanized-iron cap provided with an internal groove into which the No. 6 ground wire is wedged between the inside of the cap and the ground pipe. The cap protects the end of the pipe while it is being driven and makes a rigid contact. Experience indicates that reliance should not be placed on a single ground, and a safe plan is to install at least two grounds on each secondary. It is possible that some time in the future the practice will become standard of grounding the neutral wire of each house service to the water-piping of the house.

REGULATION.

Good voltage regulation in a suburban system is a matter of investment as well as of intelligent operation. If the income, either present or prospective, warrants the expenditure, it is possible to obtain almost as good regulation with alternating current as with direct-current distribution. A good deal depends upon the regulation at the power-house, and perhaps greater results can be obtained from relatively small expenditures on exciters and Tirrell regulators in the station than from larger amounts spent in reconstructing the distribution system. In a well-designed distribution system, feeders of sufficient capacity run from the station or substation to centres of distribution. No primary main or transformer should be tapped off between the station and centres of distribution. From these centres primary mains radiate, supplying service transformers, which feed into secondary buses or supply individual customers. Primary mains and secondaries must be so proportioned that the difference in voltage between the nearest and farthest customers will be small. In other words, the greatest drop must be on the feeders between the station and centres of distribution, and not on the mains and secondaries.

DISTRIBUTION LOSSES.

It is not sufficient to install output meters on the generators alone. A comparison between total output generated and total output sold may indicate excessive losses, but in order to run them down it is usually necessary to make this comparison on each feeder. If individual meters on each feeder can not be afforded, the station wiring should be so arranged that meters can be conveniently installed for periodic tests on each feeder.

LIGHTNING PROTECTION.

For suburban transmission at voltages from 6,600 to 22,000 the standard methods of protection seem to be very satisfactory, except, possibly, in certain localities where the lightning is especially prevalent or the lines greatly exposed. The ordinary practice is to install lightning arresters of the graded-shunt-resistance type at the stations and substations, with no intermediate protection. In a system with which the writer is familiar—where suburban transmission lines aggregating sixty miles in length and operated at 10,000 volts, with a capacity in transformers of 3,500 kilowatts in sizes of from fifty to 200 kilowatts, of both the oil-cooled and air-blast types, are protected in such a manner—no transformer has been injured by lightning within the past three years. The overhead ground wire was largely used a number of years ago on western transmission lines. It was discarded in many cases on account of trouble caused by the use of poor material and a poor method of suspension. Its efficacy as a protection from lightning seems to be without question, and it is again rapidly coming into use. Experience seems to indicate that any pole-type lightning arrester for lines operated at 2,200 volts must be mounted in a wooden box. On a suburban distributing system, where the lines are likely to be long and the business scattered, it is impracticable to attempt to install lightning arresters one-half mile apart or less, as is ordinarily recommended.

STREET LIGHTING.

Suburban street lighting differs from city street lighting in the more extensive use of series incandescent lamps, which are well suited for lighting streets where the foliage prevents proper distribution of light from arc lamps and where smaller units are more satisfactory. These lamps, in candle-powers of twenty and upward, are mounted on brackets attached to the poles or suspended in the centre of the street like arc lamps. Combinations of arc lamps in the business sections and series incandescent lamps in the residence sections are also common, in some cases both arc and incandescent lamps being installed on the same circuits. From the point of view of distribution, the combination of street lighting with commercial lighting has both advantages and disadvantages. The public funds available for street lighting are usually insufficient to pay for the proper number of lamps, consequently they are placed as far apart as possible in order to satisfy all the taxpayers. This applies to street incandescent lamps as well as to arc lamps; in fact, incandescent lamps are often selected by public authorities because they can thus light more miles of streets after a fashion with the same appropriation of money. This results in a large

investment in overhead work, a great part of which is used exclusively for street-lighting circuits. This is sometimes advantageous in that pioneer lines are for street lighting and can be erected without the opposition from property owners sometimes aroused by pole lines for commercial lighting. On the other hand, street-lighting circuits necessarily have to be run largely on the streets and there is a great temptation to distribute for commercial lighting from the streets instead of the alleys because any other course seems to result in a duplication of pole lines. The proper course to adopt in such cases depends upon local conditions. If the character of the neighborhood is such that opposition will develop, in the course of time, to the presence of overhead wires on the streets, the commercial distribution should be installed in the alleys, regardless of the fact that more or less duplication of lines results. If, on the other hand, the district is inhabited by a class of people who are not inclined to be fastidious about such things, such a course is not necessary and the system can be adopted that will result in a minimum investment in pole lines.

UNDERGROUND CONSTRUCTION.

The constant agitation against overhead wires in the cities has drawn the attention of suburban towns and villages to the matter and has very often resulted in the passage of ordinances requiring wires to be placed underground in portions, if not all, of such towns and villages. It is a difficult matter, of course, to convince the citizens of these small towns that conditions are entirely different in the country from those in the city, and that the expense of underground construction is only justified where the business is concentrated. Suburban companies are frequently obliged, therefore, from motives of public policy, to do a certain amount of underground work. If situations of this kind are not properly anticipated and taken care of, the suburban company may find itself in the position of being forced to adopt a type of extremely poor and cheap underground construction in order to cover the most territory with the least investment. This is poor policy, because, of all the different kinds of equipment that go to make up an electric lighting system, the part least subject to depreciation is underground conduit, which, if properly installed, will last for a great many years.

In selecting the type of conduit for suburban work the character and probable future development of each part of the district must be taken into consideration. For trunk lines under paved streets a durable type, such as vitrified-clay tile, laid in concrete, with plenty of extra duct capacity and roomy and well-drained manholes, is cheapest in the end. For outlying districts, where the lines can be laid inside the curb in the parkways, under turf, a cheaper type of conduit can be used. For this purpose there are available various kinds of conduit, such as wood pump log, bituminized-fibre pipe and plain sewer pipe laid with cement around the joints. There seems to be a field, also, for armored cable in outlying suburban districts. This cable is rubber-insulated and lead-encased, with an outer armor of steel tape covered with jute. It can be laid in the ground and protected with a plank, or even left unprotected. It can be had in lengths of 1,000 to 1,500 feet and forms an inexpensive type of construction well adapted for long primary runs into large estates, also for laterals and arc-lamp loops. For the runs in conduit, either rubber or paper-insulated lead-covered cable may be used. Paper-insulated cable is less expensive than rubber and is probably more largely used at the present time.

POLE-LINE RECORDS.

In an overhead-distribution system the wires, poles and transformers are in plain sight and easily located. A simple system, which the organization is able to keep up to date, is better than a very complete system that has to be neglected now and then in the press of other work and is apt to be six months or a year behind. The essential features for commercial distribution are: First, a record of each transformer, showing, in addition to the data on the transformer itself, its location, feeder from which it is supplied, and its connected load. If a three-wire secondary bus is supplied, the record should show how the connected load is divided between the two sides of the bus. The transformer record is usually kept in the form of a card index. Second, a record of each feeder, showing route followed from station to centre of distribution, with its system of primary and secondary mains. This record is usually in the form of a map on which the size of wire and location of transformers, lightning arresters, fuses, and so forth, can be indicated.

When the company is not large enough to afford a department of records, it is wise to make this work a part of the routine work of several employés, both to secure a check on the work and to insure its being carried on through the inevitable changes in the personnel of the organization.

Electrical Men Enjoy Planked Shad and Waffles.

Mr. Charles E. Trump, president of the Novelty Electric Company, of Philadelphia, gave his annual planked-shad dinner to a number of New York friends on Wednesday of last week. The dinner was given at Washington Park, of which W. J. Thompson, the well-known electric railway man of New Jersey, is proprietor, and the menu was as follows:

Planked Shad and Roe
Relishes
Bermuda Onions — Cucumbers — New Tomatoes
Radishes
Vegetables
New Potatoes — Green Peas — New Asparagus
Waffles
Ice Cream and Strawberries
Fruit — Coffee

Besides the host there were present: H. Durant Cheever, Captain W. L. Candee, George T. Manson, Charles W. Price, Colonel Ezra DeForest, W. H. Hodgins, all of New York city. A number of the party were taken over in Mr. Cheever's fine Packard automobile the previous day, and all of them returned the same way on Wednesday evening after the dinner. The return trip evidently included a mascot, for there were no punctured tires; but a different story will have to be told respecting the trip from New York over, as three tires were punctured, and on each occasion, to the great chagrin of the travelers, the accident occurred in the country wild, where only fresh and purling spring water was obtainable to quench thirst.

This was the sixteenth planked-shad occasion, and Mr. Trump has generously extended an invitation to the seventeenth, which was enthusiastically accepted by the entire party.

North Dakota Independent Telephone Association.

At the annual meeting of the North Dakota Independent Telephone Association a resolution was passed by which the members of the association present expressed themselves in favor of having the toll lines of different companies connect on the switchboard in towns where there are only one local exchange and two toll companies, so that patrons of both companies can secure the benefit of either toll line.

The following officers were elected for the ensuing year: president, L. A. Jacobson, Hope; vice-president, C. L. Lane, Kensal; secretary-treasurer, John Carmody, Hillsboro.

POTENTIOMETER DESIGN.

BY JOSEPH H. HART.

There is no doubt in the mind of the physicist to-day that of all known methods of measuring electromotive force the potentiometer method is by far the best. The high-resistance galvanometer or volt-

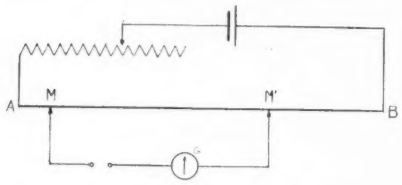


FIG. 1.—SIMPLE FORM OF POTENTIOMETER.

meter is used now only when a potentiometer is unavailable, or for rough work. The reasons for this development are probably the design and arrangement of the instruments as much as the simplicity and accuracy of the method. No laboratory is complete to-day without a large and accurate potentiometer. The same can be said of industrial laboratories and commercial projects where accuracy in electrical work is at all required. Prominent European physicists and engineers have for a number of years past made use of the potentiometer, not only in the accurate measurement of electromotive force, but also current, and it is a safe statement that this method is now recognized as the most accurate and satisfactory method for this measurement. In addition, it can be used to compare resistances, and offers an especially useful method of comparing those which are too

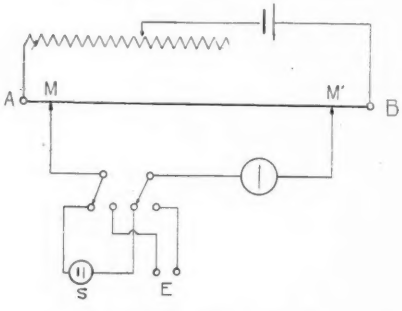


FIG. 2.—CONNECTIONS FOR COMPARISON WITH STANDARD CELLS.

low to be measured by the ordinary Wheatstone bridge. It has a very considerable range of usefulness, being applicable to the determination of very small electromotive forces, such as are required in the measurement of temperature by means of a thermo-couple. It is also used, in this development, in the measurement of resistance of platinum thermometers, and the application in this field is increasing. A number of designs based on fundamentally different principles have been put on the market, and the user of such a device is often appalled by the complexity of the connections and a not too clear understanding of the theory. Under the circumstances it seems best to go more fully into the theory and developments of the potentiometer method before considering the various developments possible in this field.

The potentiometer method of measuring electromotive force consists briefly in sending a variable amount of a constant current, by means of a shunt, through a sensitive galvanometer and through the unknown source whose electromotive force is to be determined in the opposite direction to its own current, and varying the conditions until the two opposing currents in the shunt are balanced as shown by the zero reading of the galvanometer. If the current has been kept constant through the main circuit and the balance

FIG. 3.—USE OF COILS WITH CONTACT POINTS.

obtained in the shunt by shifting the points of contact of the shunt with the main circuit, the unknown electromotive force is equal and opposite to that in the shunt, since the currents are equal and opposite and the resistance the same, and the electromotive force at the points of contact of the main circuit and shunt is proportional to the resistance included between the shunt contacts in the main circuit by Ohm's law. If a standard cell of known electromotive force is first balanced in the shunt and then the unknown electromotive force placed in the shunt, the resistances in the main circuit, in the two cases, included between the points of contact in the shunt are directly proportional to the electromotive forces used in the shunt in the two cases, provided the main current is constant, and thus, from the proportion, the unknown electromotive force can be readily determined in terms of the electromotive force of the standard cell. The advantages of the method consist, first, in the fact that the balancing is brought about by a null method, and therefore has a high degree of accuracy, and, second, in the fact that the measurement of electromotive force then depends upon the measurement of resistance, and this also can be done with a high degree of accuracy.

In the practical development of the method a high-resistance wire is included in the main circuit and stretched over the scale, as in an ordinary slide wire bridge, and the current is taken off in the shunt by means of sliding contacts. The resistance in the main circuit included between the shunt contacts is proportional

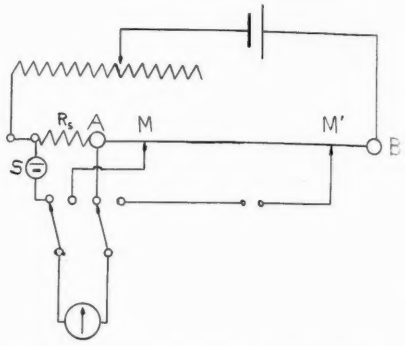


FIG. 4.—BALANCING WITH POTENTIOMETER.

to the distance on the scale between the shunt contacts, provided the wire is of uniform diameter and has a constant coefficient of conductivity. In the first and simplest form the potentiometer may be represented in the diagram in Fig. 1, and points M and M′ are sliding contacts and are moved along the wire AB until a balance is obtained on the galvanometer G. No provision has been made for inserting standard cells, but this can be readily accomplished, as shown in Fig. 2, and a comparison made. The chief objection to this method is that the points M and M′ must be moved for the different electromotive forces of the unknown and standard sources. In addition, the wire AB is too long and clumsy to operate, except in a few of the simpler low-range instruments. This latter difficulty is obviated

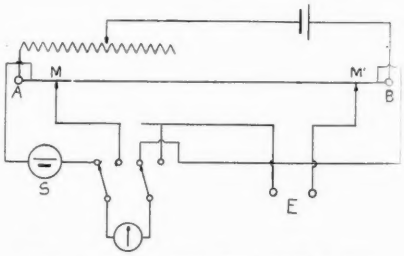


FIG. 5.—SIMPLIFIED FORM OF BALANCE.

by using coils with contact points between them, as shown in Fig. 3, in place of the resistance AB. The objection which holds owing to the change in contacts M and M′ for reading unknown and standard electromotive forces can be obviated and is generally accomplished by taking the balancing points for the standard at some

other point along AB, as shown in Fig. 4. This presents a possibility of error, owing to the two different resistances employed, and the design sometimes takes a form shown in Fig. 5.

Having now become familiar with the general designs in potentiometer theory, we come to special applications for convenience and accuracy. The main requirements in this theory are that the current shall be kept constant throughout the main circuit between points of contact, and M and M′ be moved easily over a wide range. The resistances in this main circuit must be high in order to avoid effects due to the shunt. In practice a very large number of accurate resistance coils must be inserted in the circuit and the slide contacts made over a wide range, and this is difficult to accomplish with ease of manipulation and construction. The type shown in Fig. 6 represents the general type of potentiometer as manufactured by European makers. The coils are arranged with contacts in a series of semicircles and rotation of the switches at the points M″, M‴ and M⁗ throws the resistance at choice between or outside of the points M and M′ without varying the total resistance in the circuit.

Another method of attacking the problem in practice is shown in Fig. 7. The current in the main circuit is shunted through another resistance with coils arranged to subdivide this resistance and the contact points occur as shown by arrow heads. The theory in this device is much more complicated, owing to the addition of the shunts, but the resistances can be constructed and the contacts so marked that the resistance between the points M and M′ can be read off directly.

These two figures represent diagramatically the two most prominent and accurate types of potentiometers on the market to-day. The first is more common in European practice and is distinctly the more simple to understand and the easier to operate. The resistance coils in M″, M‴ and M⁗ are nine in number and alike in each series, representing possibly 100, ten and one-ohm coils. The number of resistance coils which must be accurately calibrated in this method is much greater than in the second. The large number of slide contacts in the second, however, made the construction a matter of considerable more difficulty. The European type does not permit of the best method in the applying of standard cells, and no permanent points for this purpose can be arranged on the potentiometer wire proper, on account of the varying resistance between the points L and K. It further introduces a large number of contacts directly into the potentiometer circuit, which may bring about serious errors in this construction, which requires great care. In the other type there are fully as many slide contacts, but these enter in the shunt connection, and allowable variations in the resistance of these do not, from a theoretical consideration, affect the result within the limits of measurement.

However, owing to the difficulty of understanding the operation and theory of this latter type, the European instrument

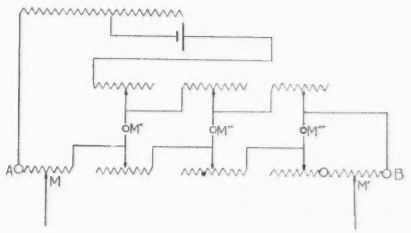


Fig. 6.—General Type of Potentiometer as Made by European Manufacturers.

is more popular and more satisfactory for ordinary work. In physical laboratories and special standardizing establishments the latter type is superior. The accuracy which can be obtained, however, in a modern instrument of the European type, known technically as the Wolff potentiometer, is quite sufficient for all reasonable purposes even in such establishments, and is in much more general use. This development in temperature measurements based upon electrical phenomena is but at its inception, and the utilization of this instrument in many power plants and manufacturing establishments is becoming more general for calibrating and verifying instruments. It goes without saying that in commercial work, as well as work of a technical or industrial character, its utilization is unsurpassed by any other instrument for measuring in this field. Current and resistance can be measured readily by the utilization of Ohm's law, and the instrument offers a most satisfactory method for accurate determinations in all electrical measurements.

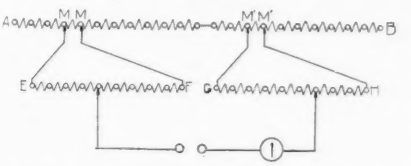


Fig. 7.—Another Method of Making a Balance.

German Street Railway Statistics.

Statistics dealing with the street railways of Germany for the year ended March 31, 1907, have been compiled and issued recently by the German Ministry of Public Works. The number of systems was 235, this being an increase of ten. The total length of all the lines was 2,332.3 miles, an increase of 132.5 miles during the year, which is equivalent to 6.05 per cent. The number of cars in use in Prussia was 11,918, which represent seating and standing room for 390,630 passengers. In the rest of Germany there were 5,152 cars in use, with seating and standing room for 160,427 passengers. Thirty-two and one-half per cent of the lines in Prussia have a gauge of four feet eight and one-half inches, and 61.1 have a gauge of three feet three inches. The gauge of the remaining roads is less than the latter. In other parts of Germany but 10.3 per cent of the roads have a gauge of four feet eight and one-half inches, and 64.7 per cent of three feet three inches. The percentage of the roads having a gauge narrower than the latter is twenty-five. There are seventeen street railways still operated wholly, or in part, by steam locomotives; twenty-seven by horses and eight by cable.

The Society for the Promotion of Engineering Education.

The sixteenth annual convention of the Society for the Promotion of Engineering Education will be held at Detroit, Mich., June 24 to 27. This will be a joint meeting with the American Society of Mechanical Engineers. An excellent programme has been arranged and a number of special features have been planned to celebrate the fifteenth anniversary of the founding of the society. Further information can be obtained by addressing the secretary, Professor Arthur L. Williston, Pratt Institute, Brooklyn, N. Y.

Annual Meeting of the New York Electrical Society.

The annual meeting for the election of officers of the New York Electrical Society will be held at the Hotel Astor, Broadway and Forty-fourth street, New York city, on Wednesday, June 17, at 8 P. M.

After the election Fred A. Muschenheim will deliver an address entitled "The Use of Electricity in the Modern Hotel." This will be illustrated by lantern slides. After the address there will be an inspection of the electrical equipment of the hotel and also of the lighting effects in the roof garden.

THE CHEMICAL EDUCATION OF THE ENGINEER.[1]

BY WILLIAM H. ELLIS.

The academic education of the civil engineer is a thing of yesterday; or, rather, it is a thing of to-day. Yesterday it was not. I use the word "civil" in its original sense. Balbus was, without doubt, a military engineer. The great roads of antiquity were built by soldiers. In the Motherland, yours and mine, there were no roads till the Roman legions made them. On this continent the canoe and the blazed trail were sufficient till Braddock's three hundred axemen hewed their way through the forest from the sea to Fort Duquesne, and our Governor Simcoe connected Lake Ontario with the lake that bears his name by the military road which, in imitation of the old Roman Watling street, he called, as we call it still—Yonge street.

But steam changed all this. With steam came railways; and with railways came the civil and the mechanical engineer, and to them has been added, in our own day, the electrical engineer. At first the civil and the mechanical engineer learned their trade, like everybody else in those days, by apprenticeship. They learned to play the fiddle by playing the fiddle, without any lectures on the physical and the physiological bases of harmony or any exercises "zur Fingerfertigkeit." And grand musicians they were, those old masters who wrote their opera on staves of iron ruled across two continents; whose treble was the shriek of the locomotive, and whose bass was the roar of the blast furnace, whose choruses were sung by the toilers of the nations, and whose libretto was the record of the world's progress.

It is a truism that genius often gains its end by bursting barriers and breaking rules. But for all that we have come to think that education will not hinder the genius and will surely help the engineer.

It is noteworthy that France, where one word stands for both genius and engineering, led the way in this matter. Engineering education dates from the foundation of the École des Ponts et Chausées. Germany followed; then America, like one born out of due time, but now become the greatest of the Apostles. Nay, at last, even my countrymen, clothed as they are with a contempt for theory which throws off the undulations of the intellectual ether more completely than polished nickel, backed by a conservatism more impermeable than infusorial earth, even Englishmen are giving signs of viscosity; and British public opinion is flowing forward with a motion like that of a glacier, slow, indeed, but sure and irresistible.

We agree, then, that the engineer shall be educated. But shall chemistry form one of the subjects of his education? Assuredly, yes. For what is an engineer? He is a man who devises and supervises the construction and use of engines—contrivances—that is, for yoking the forces of nature to the service of man; and what are chemistry and physics but the ordered and methodical study of these forces and of their action on the materials of which machines are constructed and upon which they work?

I am speaking to-day as a chemist to chemists, and it is safe to say that we are all pretty well agreed as to the kind of teaching that is best for the professional chemist, whether his career is to be technical or academic.

So, too, there are certain sufficiently obvious considerations which would guide us in shaping a chemical course for a mining engineer. Chemistry is chemistry even if you call it metallurgy and assaying; and those of us who have helped to frame a curriculum in chemical engineering know that the great problem is to keep the engineering twin from smothering his chemical brother.

About all this a great deal has been written and a great deal has been said, and we are, I think, most of us, so far, in substantial agreement.

But what about the chemical education of the civil and mechanical engineer? We may at once admit that chemical problems form but a small proportion of those which confront him. It is true that the combustion of fuel, the incrustation of boilers and the rusting of metals, the preservation of timber, the setting of cement, the action of explosives, all involve questions of chemistry, and their consideration forms part of the daily work of the engineer. But in many such cases he can accept the results of previous investigations without troubling himself about the way they were obtained, and in others he can call in the chemist to his aid. The engineer is not a chemist, and for him chemistry must be reckoned as one of his "culture subjects." It is exactly here that the difficulty of the teacher begins. He is called upon to teach chemistry to boys who are not going to be chemists, who have no wish to become chemists and who ought not to be encouraged to think that they are being made chemists.

On the one hand, he must make his subject sufficiently interesting to attract to it a due share of that energy upon which there are so many other and, in the student's judgment, more pressing calls; and, on the other hand, he must not lead the student to suppose that, after attending a few lectures and performing a few laboratory experiments, he will be able to pose as a chemical expert.

This is a real difficulty; and it is all the greater because chemistry is looked upon by the public as a utilitarian subject—a study which is supposed to have, as of course it has, a practical bearing upon daily life.

One of my teachers used to illustrate to his class the value of the study of mineralogy by saying to them: "Suppose a farmer brought you a bit of hard yellow mineral and said to you: 'Sir, what is this? You have attended a course of lectures on mineralogy, can you tell me if it is any good? It occurs in great abundance on my farm. Is it gold or what is it?'" And he went on to show how, with the aid of a watch glass, the student could dissipate the golden dreams of the credulous husbandman.

One of my colleagues, who as a graduate of Oxford, somewhat grudgingly admitted that it was desirable, in a new country such as Canada, that a young man should learn chemistry, because he might through its aid discover a silver mine.

The notion that chemistry is a study which has a high value as a mental training, as a means of broadening and deepening the mental outlook—in a word, as a means of culture on a par with mathematics and languages and history—is still very far from the point of view of the man in the street.

Now, the undergraduate is the son of the man in the street; and he brings to college his father's point of view, his father's prejudices and his father's limitations—together with a cocksurety that is all his own.

Our first task, then, is to give the young engineer the chemist's point of view. Our point of view is ever changing, and our view of truth changes with it and is always incomplete. It is the tangent to the curve that represents the evolution of our knowledge of the truth, and it coincides with that curve only at that infinitesimal interval of time that we call now. As we look into the future it diverges more and more widely from the truth, and we can only keep in the true path by continually shifting our viewpoint and continually changing our views. This is the first thing we should teach our students. But our pres-

[1] Read at the Chicago meeting of the American Chemical Society.

ent view of the truth, though certainly incomplete, is not necessarily false. If our data are reliable, if our measurements are accurate, if our calculations are correct, it does really represent the facts as we now know them. It is real knowledge. It will become out of date with the lapse of time, but it will not be contradicted; it will not be exploded. This is the next thing to be taught. The recognition of these two cardinal principles constitutes the scientific habit of mind. This is essentially the difference between the mental attitude of the man of science and that of the man in the street. Our first duty is to impress this way of looking at things on the plastic minds of our pupils, not by precept only, but by example, by illustration, by reiteration till it becomes a part of their nature.

But it is not enough to give a boy the chemist's point of view. We must also try, as far as time and opportunity allow, to make him see the things the chemist sees. We must get him to look beneath the surface of the forms of matter that surround him and discern, at least in some dim way, the throbbings of the living forces within them and around them.

And here let us beware of serving up knowledge in individual platters. Do not let the student get into his head that there is one chemistry of the metals and another of the non-metals, or that organic chemistry and inorganic chemistry have any real existence except as guide cards in a catalogue.

The student's time is so short and so crowded with other studies that only a few types can be chosen. But let those types be selected so as to cover, as far as may be, the whole field; let them be as typical as possible, and make the student understand that they are types. Thanks to the great Russian Pilot, this is an easy task now in comparison with what it used to be in the days when some of us launched our bark on the yet uncharted sea.

Above all things, let us see to it that the student never for one moment flatters himself with the notion that what we require him to know is all there is of chemistry that is worth knowing! Let us make it abundantly clear to him that we are only teaching him to read the language of chemistry and that the selections we set before him are only exercises in translation—not a corpus poetarum.

When I speak of teaching the student to read the language of chemistry, I am using no empty metaphor. This is the kernel of the whole matter. What we have to do is just this—to teach him to *read* chemistry; to interpret chemical phrases; to give him clear notions as to the meaning of the conventions by which the chemist expresses his ideas.

This, as I have said before, is mental training of a high order. But it is more than that. The utilitarian side of the question must not be overlooked any more than the cultural aspect. The time will come, sooner or later, when the engineer will want to find out what is known about the chemistry of some subject in which he is interested. Very likely his need will be urgent; it is certain his time will be scant. If he has had the education I speak of, he will know where to look for information; and he can use it when he finds it. If he meets a phrase he can not construe, he will know how to use his dictionary. A statement couched in chemical language, or symbols, will not make him shut the book like a nineteenth-century chemist confronted with a sign of integration.

Nothing will arouse and retain the student's interest so effectually as frequent references to those points of contact between theory and practice, where the abstractions we are trying to teach him become concrete in the problems he will have to face.

And here let me say what I have hinted before, that it is a mistake, I am sure, to keep organic chemistry a sealed book to the engineer. If we consider the various applications of chemistry to daily life and to industry, it is surprising to note how many of them are concerned with the chemistry of the carbon compounds. Fuel, explosives, sanitation, the decay and preservation of timber, pigments, oils, paper, textile industry, fermentation, the preparation and preservation of food, all have to do with organic chemistry. Let any one read a list of patents, or the classification of abstracts in the *Journal of the Society of Chemical Industry*, and this will be made abundantly clear.

It may be objected that in the time at his disposal the student can only acquire a smattering of this great subject, and that such a smattering is worse than useless. I readily grant the first contention, but I emphatically deny the second. If by the abusive term "smattering" we mean a little knowledge, then that smattering is dangerous only when it carries with it unconsciousness of its own littleness, and I hope I have made myself sufficiently clear as to the importance of keeping always before the student his own limitations.

The cure for superficiality, that bugbear of the pedant, is not to blindfold the eyes, but to train the eyesight, and the student whose mental vision is thus sharpened will not only be able to see clearly the things that lie before him and about him on the threshold of our science, but he it is who will most readily discern the vastness and the richness of the territory at whose frontier he stands; and he who will most humbly and most surely walk in any of its paths along which his business or his pleasure calls him.

New Use for Silicon.

Vice-Consul W. Washington Brunswick, of Barmen, Germany, in a recent consular report, states that considerable development has taken place in Germany in the use of silicon copper for the augmentation of the hardness and firmness of bronzes. A recent use of silicon to obtain a pure copper casting and copper alligation was successful. The foundry trade has always experienced difficulty in making copper castings, due to the formation of oxides in the melt. As a reduction agent, phosphor is generally used, but late experiments by English experts proved that additions with silicon copper are better. They clean more effectively, harden and tighten better the copper structure and its alloys. The reason for this is that the unification of copper silicon has a higher heat effect than copper alone, and silicon impairs the oxidization. Although ignition follows very easily when silicon copper is added to silicon, there is, however, no danger of explosion. The addition is given with one and one-half to 100 pounds copper. The copper thus treated is particularly recommended for electrical conductors. It is more easily drawn to wire than copper combined with phosphor. The wires are better for telegraphic and telephonic purposes, because they do not corrode and possess a maximum conductive power, and, owing to minimum thickness, are lighter.

Rate Change for Edison Electric Illuminating Company, of Boston.

The Massachusetts Gas Commission has recommended that on and after July 1, 1908, the Edison Electric Illuminating Company, of Boston, Mass., reduce the price for electricity for any use to a uniform price not to exceed twelve cents per kilowatt-hour; and that on or before October 1, 1909, this uniform price shall be further reduced as may be approved by the commission, unless the company shows good cause why such further reduction should not be made.

American Society of Mechanical Engineers.

The spring meeting of the American Society of Mechanical Engineers will be held in Detroit, Mich., June 23 to 26. Headquarters will be established at the Hotel Cadillac, while the professional sessions will be held in the convention hall of the hotel. By mutual arrangement the following societies will hold their conventions simultaneously with the Mechanical Engineers: Society for the Promotion of Engineering Education, Society of Automobile Engineers, and the Society of Gas Engine Manufacturers.

The opening session of the convention will be held Tuesday evening, June 23, at 9 o'clock, when the society will be welcomed to Detroit, the response being made by President M. L. Holman. A social reunion and formal reception will follow the addresses.

A business meeting will be held Wednesday morning, June 24, at 9.30. Following this there will be a symposium on machinery for hoisting and conveying materials, during which the following topics will be discussed: "Hoisting and Conveying Machinery," G. E. Titcomb; "Continuous Conveying of Materials," S. B. Peck; "The Belt Conveyer," C. K. Baldwin; "Conveying Machinery in a Cement Plant," C. J. Tomlinson, and "Belt Conveyers," E. J. Haddock.

Wednesday afternoon a session will be held at 2 o'clock to continue the above discussion, and the following papers will be presented: "The Thermal Properties of Superheated Steam," by R. C. H. Heck; "A Rational Method of Checking Conical Pistons for Stress," by G. H. Shepard, and "A Journal-Friction Measuring Machine," by Henry Hess.

Wednesday evening there will be a lecture, at 8.30, by Professor J. A. Brashear, of Allegheny, Pa., on "Contributions of Photography to Our Knowledge of Stellar Evolution."

Thursday morning, June 25, the society will be tendered a trip by steamer to the shipyard of the Great Lakes Engineering Works, at Ecorse, to witness the launching of the William B. Meacham, and to see the sinking into place of the fourth section of the Detroit tunnel. The steamer will start at 10 A. M., and return in time for lunch.

Thursday afternoon a session will be held at 2.30 and the following papers will be presented: "Surge Tanks in Water Power Plants," by R. D. Johnson; "Some Pitot Tube Studies," by W. B. Gregory and E. W. Schoder; "Comparison of Screw-Thread Standards," by Amasa Trowbridge, and "Identification of Power-House Piping by Colors," by W. H. Bryan.

Simultaneously with the last-mentioned session, another will be held at which the following papers will be presented: "The By-Product Coke Oven," by W. H. Blauvelt; "Power Plant Operation on Producer Gas," by G. M. S. Tait; "Horse-Power, Friction Losses and Efficiencies of Gas and Oil Engines," by L. S. Marks, and "A Simple Method of Cleaning Gas Conduits," by W. D. Mount.

Thursday evening a reception will be held at the Hotel Cadillac at 9 o'clock. This will be the distinctively social feature of the meeting.

Friday morning, June 26, the fifth session will be held to hear and discuss the following papers: "Economy Tests of High-Speed Engines," by F. W. Dean and A. C. Wood; "Air Leakage in Steam Condensers," by T. C. McBride, and "Clutches," by Henry Souther.

An afternoon and evening sail on the Detroit River will take place on Friday afternoon. The steamer Britannia will leave Detroit at 3 P. M., sail around Belle Isle and down the river to the head of Lake Erie and return to Bois Blanc Island for supper, returning afterward to Detroit.

Arrangements have been made to attach special sleeping cars to a number of trains from New York and Chicago. More detailed information can be obtained by writing the secretary, Calvin W. Rice, 29 West Thirty-ninth street, New York city.

BOOK REVIEWS.

"Principles of Direct-Current Electrical Engineering." James R. Parr. New York. The Macmillan Company. Cloth. 552 pages. Illustrated. 6 by 9 inches. Furnished by the ELECTRICAL REVIEW for $3.25.

This text-book on electrical engineering has been prepared for the students of Hariot-Watt College, Edinburgh, Scotland, to fill the specific needs of the lecturer on this subject. It assumes some knowledge of fundamental electrical principles, but reviews briefly this subject as well as the magnetization of iron. The latter subject is then extended to cover those magnetic properties of iron which are of importance in the construction of electrical apparatus. Following this, various types of electrical-measuring instruments are described, including laboratory as well as commercial types. Storage batteries, incandescent and arc-lamp lighting are concisely treated, and the distribution of electrical energy by overhead and underground conductors is explained. Following this, the dynamo is taken up, its principles dwelt upon and methods of construction shown. Methods of designing and testing are discussed at some length. The use of colored charts in this part of the book facilitates considerably the following out of the wiring diagrams. Parallel working of generators and the use of boosters and other special types of machines are explained as well as the construction and use of auxiliary apparatus, such as starters and controllers. The final chapter of the book deals with the control of electricity, by which is meant the switchboard equipment and other related apparatus. Throughout the book numerous problems are introduced to emphasize the principles explained. The arrangement of the work is a little different from that usually adopted in such books, but the sequence is always logical.

"The Theory, Design and Construction of Induction Coils." H. Armagnat. Translated by O. A. Kenyon. New York. McGraw Publishing Company. Cloth. 216 pages. Illustrated. 5½ by 8½ inches. Furnished by the ELECTRICAL REVIEW for $2.

Induction coils, until recently, found their only application in medicine, and have generally been looked upon as interesting scientific devices having but little practical value in engineering work. In recent years, however, the induction coil has taken on a new significance. It has become exceedingly important, due to the development of the internal combustion engine and in the fields of wireless telegraphy and telephony, and besides has become invaluable as an adjunct in the use of X-rays. For these reasons considerable attention has been paid to the best methods of construction of the coil itself and accessory devices. In this book the author gives an excellent and thorough study of the theory of the coil and the theory of interrupters of various types, and goes into considerable detail of the best methods of construction. He very properly devotes considerable space to the consideration of the interrupter, as this is as important to the induction coil as is the commutator to the direct-current dynamo. Special forms of coil, such as the Tesla transformer, are described, and the various uses of induction coils are also discussed. The translation has been faithfully done, thus giving the English reader an excellent and thoroughly reliable work on this device. The concluding chapter is a bibliography of the subject, in each case the general character of the article being indicated.

PERFORMANCE OF THE STORAGE BATTERY AND ITS RELATION TO THE POWER PLANT.

W. B. GUMP.

In many continuous-current systems, and especially in railway work, the fluctuations of the load demand some auxiliary which will aid in carrying heavy loads, and in doing so prevent a violent drop in voltage. This is accomplished by means of a storage battery, which during light loads may be charged, and during the demands of heavy loads is capable of giving out energy to the system. A battery may do this through continuous periods of several hours respectively, or may intermittently charge and discharge, according to the load in question.

A storage battery in connection with an electric plant is analogous to a reservoir used in a pumping system, this reservoir acting as a medium for storage. During light demands the water is being accumulated in the reservoir, and when an increased supply is needed the surplus water which has been stored is drawn upon. By this method the capacity of the pumps need be only equal to the average demand. Furthermore, there is far less strain imposed upon the pumps due to sudden fluctuations which could not be prevented without a storage system. Similarly a storage battery will accumulate energy during loads which are below the average, and discharge into the system when abnormal current is required, thus relieving the generators and smoothing out the load curve.

The ability of a storage battery to give out a large current for short periods has made its place important in railway installations. The main disadvantages of the storage battery are its high first cost, its care and its maintenance. It can be readily shown, however, that these disadvantages may in many cases be eclipsed by the material increase in annual profits due to its installation. It is safe to say that a storage battery is a useful, if not a necessary, adjunct to almost every railway system. Storage batteries are also used in connection with isolated plants, particularly for lighting. In such cases it is usual to charge the battery during the day, and allow it to energize the lighting circuit at night, when the engine and generator may be shut down.

PERFORMANCE OF STORAGE CELLS.

A storage cell is made up of a metallic couple—which may be called the "element"—immersed in an electrolyte. Up to the present time lead has been found to possess the most advantageous qualities for the element, the electrolyte being dilute sulphuric acid. In the formation of the negative plates it is the practice of manufacturers to apply the active material mechanically; that is, to "paste" the plates instead of forming them by means of a long series of charges and reversals, respectively. The latter process is known as the "Planté" formation, and the "pasted" process as "Faure," after names of the early inventors. It has been found by experience that the positive plates are usually most satisfactory when formed by the Planté process.

On charging a battery the active material on the positive plates is converted to lead peroxide (PbO_2) and the negative plates to sponge lead (Pb).

On discharge, the reverse action follows, both sets of plates being partially changed to lead sulphate ($PbSO_4$), the electrolyte becoming dilute, and the density therefore decreasing. The general equation of the reaction is:

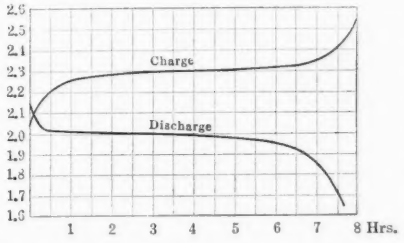


FIG. 1.—CHARACTERISTIC STORAGE BATTERY CHARGE AND DISCHARGE CURVES.

$$PbO_2 + Pb + 2H_2SO_4 = 2PbSO_4 + 2H_2O$$

Discharge.....>

<.....Charge

The end of charge is best observed by noting the density of the electrolyte, which reaches its maximum after a certain period and remains constant.

At the beginning of charge the potential of a cell is about two volts. The voltage rapidly increases (as shown in Fig. 1) and holds practically a constant value nearly to the end of charge, when it again increases. On discharge the opposite phenomenon takes place. The duration of charging is reckoned on a basis of eight hours, as charging in less time is not advisable, and is liable to injure the plates. Vehicle batteries are charged in four hours, and often in less time. Such procedure, however, is at the sacrifice of the life of the battery.

The capacity of a cell is measured in ampere-hours. The capacity is found to decrease as the rate of discharge increases; for example, a battery rated at fifty amperes for eight hours, or 400 ampere-hours, may be tabulated as follows:

						Per Cent.
Discharging	8	hours at	50	amp.	capacity,	100.0
"	5	" "	70	"	"	87.5
"	3	" "	100	"	"	75.0
"	1	" "	200	"	"	50.0

A storage battery to be used for railway service is generally based upon the rate of discharge for one hour. When unusually heavy fluctuations are to be met a twenty-minute rate is sometimes specified. This rate will equal twice that of the one-hour discharge, which in the above case is equal to $2 \times 200 = 400$ amperes; $400 \times 1/3 = 133.33$ ampere-hours, or $\frac{133.33}{4} =$ 33 1/3 per cent of the eight-hour capacity.

Experience shows that a battery should not be discharged below about 1.8 volts per cell, as discharging below this will cause "sulphating," which rapidly disintegrates the plates. It therefore follows that a battery should never be allowed to stand when in a discharged condition, as a further discharge is liable to occur either by means of its coming directly in contact with apparatus to which it is attached or through leakage. Lead sulphate when present may be readily detected by its white color. It offers a high resistance to the passage of an electric current and becomes practically an insulator. In consequence of this condition it becomes difficult and often impossible to recharge a battery which has become "sulphated."

END CELLS AND THEIR USE.

On account of the variation in voltage between the beginning and the end of charge, as well as the beginning and end of discharge, it becomes necessary to employ some means of maintaining a constant voltage. This is done most simply by cutting in or out cells connected to the main battery. These are commonly known as "end cells." In some instances counter-electromotive-force cells are used. These are connected in series with the main battery, and "buck" the voltage of the main battery. The latter method is little used, however, and will not be discussed.

In Fig. 2 is shown the simplest arrangement for charging. Suppose that the battery is connected either to a lighting circuit which is energized during the day, or directly to a generator used for the purpose of charging. At the beginning of charge the voltage per cell will be

two volts. If the voltage across the mains is 110, then there will be $\frac{110}{2} = 55$ cells. As the counter-electromotive-force increases (that is, the voltage per cell), the end cells must be gradually cut out, until finally at the end of charge there will be

$$\frac{110}{2.6} = 42 \text{ cells in circuit.}$$

This assumes, of course, that the voltage of the generator also may be varied. On discharge, the end cells are gradually cut in until finally all of the cells are on the line. It will be seen that the length of time of charging the end cells varies with each cell, from a small amount on the last

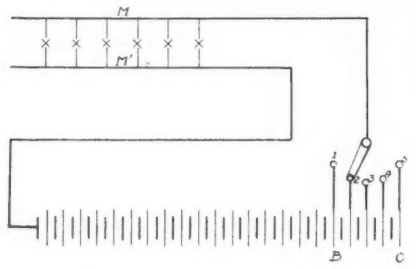


FIG. 2.—SIMPLE ARRANGEMENT FOR CONNECTING UP BATTERY AND END CELLS.

cell to the maximum length of time on the cell next to the line battery. On discharge, the same length of time for each corresponding end cell is followed, the cells gradually tapering off, to the last end cell, which discharges only for a short period. Theoretically the line would taper off to zero if an absolutely constant voltage were maintained. This condition, however, can not be met in practice.

It is sometimes necessary to charge a battery without allowing the lights to be

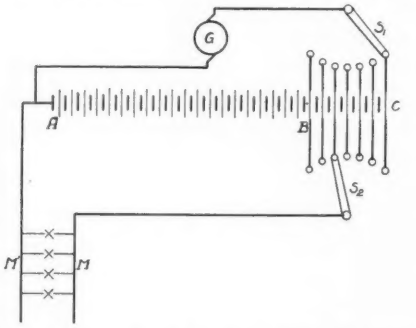


FIG. 3.—ARRANGEMENT FOR CHARGING BATTERY WHILE SUPPLYING CURRENT.

cut off. An arrangement of this kind is shown in Fig. 3, in which S_1 is an end-cell switch on the generator side, and S_2 is in series with the lighting circuit, the two end-cell switches being in parallel. In this system the generator must be large enough to supply both the charging current and the current for lighting, the circuit for the latter being in parallel with the battery. It should be observed that the end cells will have to be twice the capacity of the cells in the main battery, for the reason that at the beginning of charges the current through the end cells will be equal to the battery current plus the current for lighting service, since S_1 will be in the position shown, while S_2 will have the end cells cut out.

A method of charging in parallel and discharging in series is shown in Fig. 4. In this system there is considerable loss due to resistance while charging, but the method is often convenient, and is very simple. It is advisable to have an ammeter for each side, so that the current may be kept the same, and thus charge both sides alike.

FLOATING AND BOOSTER SYSTEMS.

The simplest case in which a storage battery can be used as a medium for regulation is that represented in Fig. 5. The battery is connected across the line, and depends for its operation upon the drop which occurs on heavy loads. It is made up of a sufficient number of cells to equal the voltage of the average load on the system, assuming two volts per cell. Under these conditions a battery is said to "float" on the line. Suppose that the maximum voltage (assuming it to be a railway system) is 550 volts, and the minimum is 400 volts. The average will then be 475 volts. This would require a battery of 238 cells at an average of two volts per cell. It is evident that such a battery should be located near the end of the feeder system in order to become sufficiently charged to relieve the generators. The battery never becomes fully charged or fully discharged. It therefore becomes necessary at frequent intervals to charge the battery to full capacity, and to give it an overcharge occasionally. This will prevent sulphating, which would otherwise occur.

Where a constant voltage is required on systems with widely fluctuating loads it is not possible to use end-cell switches. For such cases some form of differential booster is employed. There are many forms of such boosters, but they all operate in much the same manner. Among the most common is that of J. B. Entz, shown in Fig. 6. The object of this system is to maintain a constant load on the generator, forcing the battery to take all of the load above that of the generator. There are three coils on the booster field. The coil S_1 is in series with the generator lead, S_2 is in the main line, and receives current from both the generator and the battery, when the latter is discharging. The shunt field f is connected across the line. The fields S_1 and S_2 are wound so as to oppose the shunt field f. Since the generator load is constant, the field S_1 is constant. The shunt field is somewhat variable, but not to such an extent as S_2.

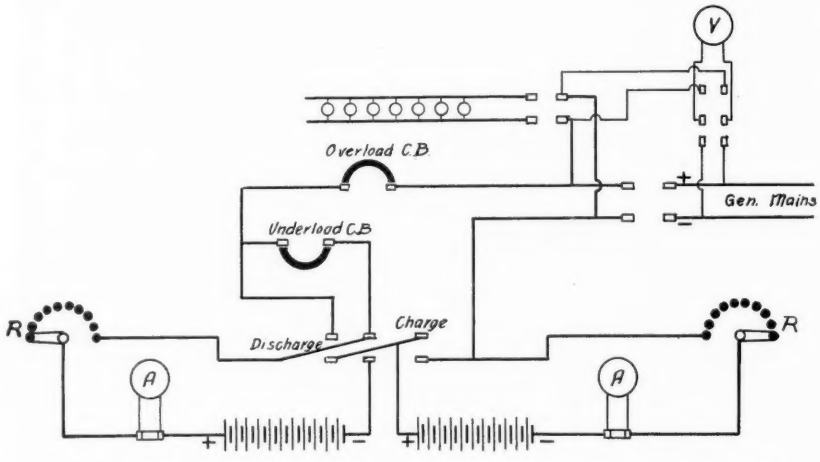


FIG. 4.—ARRANGEMENT OF CIRCUITS FOR CHARGING IN PARALLEL AND DISCHARGING IN SERIES.

Suppose that a sudden and heavy load comes on the line L L^1. This will immediately create a field in S_2 which will overbalance the shunt field and raise the voltage on the booster, assisting the battery to discharge. When the current is below normal, and S_2 becomes weak, the effect is reversed, allowing the battery to be charged. The function of the coil S_1 is to act as a "compensator" during either very light or very heavy loads. First assume that there is only a light current flowing in the mains L L^1 and the battery is fully charged. The field produced in S_2 will have practically no effect on

the shunt field, and the result will tend to charge the battery, instead of allowing the generator to take all of the load. As the generator tends to send current into the battery the field S_1 increases, neutralizing the effect of f and restoring the booster potential to a point where the battery will neither charge nor discharge. If the battery is completely charged it will tend to take more than a proper proportion of load. This will reduce the current in S_1 and thus allow the field f to act against S_2, reducing the booster

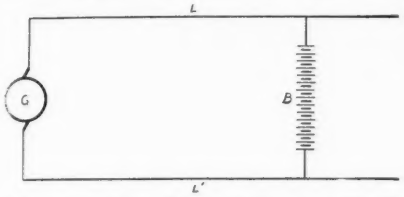


FIG. 5.—SIMPLE ARRANGEMENT OF REGULATING BATTERY.

voltage to a point which will force the generator to pick up its full share of load. The rheostat R is used to adjust the strength of the shunt field and thereby regulate the latitude of the booster.

Fig. 7 shows a similar arrangement to the one just described, and is known as the "Storer System." In this system the differential field coils act upon an exciter E, from which the booster field is energized, instead of producing the field variations directly on the booster itself. The scheme shown has been modified by employing shunts in place of the coils S_1 and S_2. In this way the full line currents are not passed through the respective field coils, but only a proportionate amount. This method gives the desired results, and effects a decided saving in copper.

DETERMINING THE SIZE OF BATTERY.

The factors which determine the size of battery to install are based upon the operating conditions; for example, a battery which is to operate in an isolated plant, taking the entire load during the night, must necessarily be of greater capacity than a battery (for the same plant) which is to carry only a peak load. Again, the size of a battery to operate in connection with elevators must have only sufficient capacity for regulating; that is, taking intermittent peaks, thereby relieving the generators and maintaining constant voltage on the lighting circuit. In many isolated plants the size of the generating units may be reduced as much as fifty per cent by employing a storage battery. This fact may be readily understood when one considers the conditions to be met. A plant in which there is to be lighting only, and this for only a small period during the twenty-four hours, demands that the machinery be idle most of the time. By means of a storage battery the machinery can be used for charging during the day at a moderate rate, and at night may be shut down, allowing the battery to take the evening and morning peaks. The capacity of the gen-

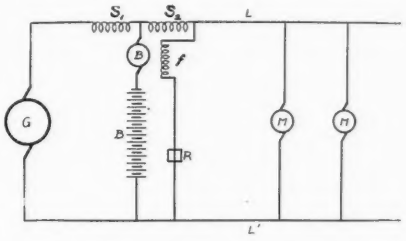


FIG. 6.—"BOOSTER" CONNECTIONS.

erators in this case would be only that necessary to take the average load, and would hence be considerably smaller than would be permissible if the generators had to carry the evening and morning peaks alone.

In deciding the size of the battery to install, the first question to be settled is the maximum overload which will be permitted on the generators, the battery to

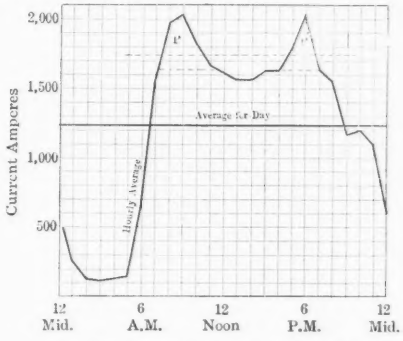


FIG. 8.—STORAGE BATTERY STUDY.

take all of the remaining load. Suppose we examine Fig. 8, which represents the load for a railway plant. The average load in this case is 1,225 amperes. Generators rated to carry twenty-five per cent overload continuously are evidently able to carry their share of the load during the peak. It is now necessary to determine what current will be required to charge the battery, in addition to that required during light load. If the battery is required to carry all of the peak—that is, all of the load above 1,225 amperes—the average peak load must first be found. This is found to be 1,740 — 1,225 = 515 amperes, as shown by the dotted line. The battery would be required to operate for a period of approximately fourteen hours. The capacity would be $14 \times (1{,}740—1{,}225) = 7{,}200$ ampere-hours. A battery this size would be prohibitive on account of its cost; hence we must confine the battery load to the peaks P and P'. It will be observed that four hours is the length of duration of the peak P. The current for this peak averages 1,920 — 1,625 = 295, say 300 amperes. The capacity of battery required

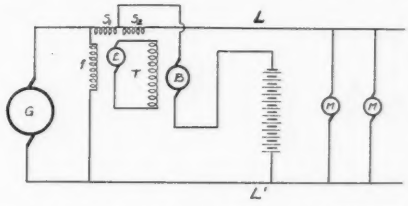


FIG. 7.—"STORER" SYSTEM OF "BOOSTER" CONNECTIONS.

will then be $4 \times 300 = 1{,}200$ ampere-hours. This battery should operate in conjunction with a differential booster if the battery is to relieve the generators completely of the peaks, and at the same time maintain a constant voltage. In order to maintain a constant voltage the generators in this case would require over-compounding. Otherwise the battery would simply "float," as formerly shown in Fig. 5. A floating battery necessarily fails to give close regulation, since it can only discharge by virtue of the drop in voltage on the line. If the line voltage is 550 volts the number of cells required will be

$$\frac{550}{1.9} = 290 \text{ cells (approx.)}$$

For a floating system the number of cells would be

$$\frac{\text{max. voltage} + \text{min. voltage}}{4}.$$ Assume

$$\frac{550 + 450}{4} = 250 \text{ cells (approx.)}$$

THE INSTALLATION OF STORAGE BATTERIES.

This subject is a broad one, and does not permit of anything like a full treatment in these pages. It is well, however, before concluding the present article, to state some of the fundamental considerations involved in connection with a proposed storage-battery installation.

It is always advisable to have a separate room away from the main station, when installing a battery. This is necessary for three reasons:

(a) On account of the acid fumes which continually arise from the cells, and cause the oxidation of metallic struc-

tures, and power-house machinery in general.

(b) Overflowing of the electrolyte, and handling same in keeping the cells in proper condition.

(c) Possibility of power-house apparatus, wiring, etc., dropping upon the battery and causing short circuits.

It is customary to paint structural iron, such as roof trusses, and columns which are a part of the battery plant, with some acid-proof paint or with a heavy coat of melted paraffin. This will prevent their becoming seriously rusted. Copper busbars and connections are readily attacked by the fumes, and should be coated with lead. It is never advisable to have running machinery in a battery room, and especially commutators, as these necessitate continual scouring in order to prevent erosion.

A storage-battery plant should always be installed by men who are experts in this particular line of work, as the life and success of a battery depend more upon its proper handling than upon any other factor. A great deal more might be said in regard to the conditions which decide whether to install a storage battery. Each case, however, is a special one, and involves good judgment, which only comes from a thorough acquaintance with all of the conditions in hand.

It should be noted that the ampere-hour efficiency of a storage battery is from fifteen to twenty per cent higher than the watt efficiency, the latter being from seventy to eighty per cent in commercial batteries. This factor must be considered when a battery is to be installed in order to provide ample capacity for charging.

National Education Association.

The forty-sixth annual convention of the National Education Association will be held in Cleveland, Ohio, June 29 to July 3. The following tentative programme has been arranged: The annual meeting of the board of directors will be held on Monday, June 29, at 11 A. M. At 5 P. M. meetings of the active members of the several states will be held to nominate candidates for appointment on the committee on nominations. On Wednesday, at noon, the annual meeting of the active members for the election of officers and for other business will be held. Besides the business meetings, a meeting will be held every day for the reading of papers or delivering of addresses. Further information may be obtained by addressing the secretary, Erwin Shepard, Winona, Minn.

The Relation of the Southern Appalachian Mountains to the Development of Water Power.

A bulletin has been published by the Forest Service of the United States Department of Agriculture, dealing with "The Relation of the Southern Appalachian Mountains to the Development of Water Power." This has been prepared by M. O. Leighton, M. R. Hall and R. H. Bolster.

In the bulletin attention is called to the immense importance of water power to the present industrial development of the South. The abundance of this power has led to the greatest development of water power that has ever taken place during a similar period anywhere in the United States. The resources represented by this water power are far greater than the present market value. Fuel must become more and more costly as the available supply is depleted, which means that the cost of fuel power, which is at present much greater than that of water power, will constantly increase, and therefore the demand for water power will increase in proportion. A low average of the present rental value of water power is $20 a horse-power-year, and this figure is used in estimating the present value of the power available for development in the southern Appalachian region.

According to estimates made by the United States Geological Survey, there is a minimum of about 2,800,000 horse-power represented by the rivers having their headwaters in the southern Appalachian Mountains. Mature consideration of the conditions leads the Survey to estimate that at least fifty per cent, and probably more, of this power is available for economic development. This figure represents merely the minimum horse-power, and if auxiliary power were provided to supply short seasons of water deficiency, it would be profitable to develop up to two and one-half times this amount. Full development of storage facilities would increase the minimum some three to thirty times, so that obviously an estimate of the present value, based on fifty per cent of the minimum horse-power, is safely conservative.

The rental of 1,400,000 horse-power at $20 a horse-power-year would bring an annual rent of $28,000,000, which is equal to a gross income at three per cent on a capital of $933,000,000. Some of this power has already been developed, but a very small portion—hardly enough to make any appreciable showing when the enormous resources of the region are taken into account. These estimates are based on the present condition of the drainage areas, and represent what can be accomplished if the present forests on the mountains are properly protected from this time on. The report then takes up in detail the available water power of the rivers on the Atlantic seaboard and those tributary to the Ohio River. The different forks of these rivers are considered separately, and in each case the length of the stream, the mean drainage area, the minimum discharge, ninety per cent of the maximum total flow, the minimum available horse-power, and other data are given. The following is a summary of the power represented by these different streams: The Potomac River, above Washington, 131,800 horse-power; the James River, above Richmond, Va., 155,000 horse-power; the Roanoke, above Weldon, N. C., 131,000 horse-power; the Pedee, above Cheraw, 171,300 horse-power; the Santee, above the junction of the Wateree and Congaree, 320,200; the Savannah River, above Augusta, Ga., 209,000; the Chattahoochee River, above Columbus, Ga., 145,000 horse-power; the Coosa, above Wetumpka, Ala., 180,000 horse-power; the Monongahela, above its mouth, 58,900; the Great Kanawha, above its mouth, 335,000, and the Tennessee River, above Riverton, Ala., 992,700 horse-power, making a total of 2,829,900 horse-power. Although these figures show that the water-power facilities are great, they do not convey an adequate idea of the immense possibilities of the region.

Time Limit for Westinghouse $10,000,000 Subscription Extended to June 22.

On Tuesday, June 2, the merchandise creditors' committee reported to the readjustment committee having in charge the plans for the rehabilitation of the Westinghouse Electric and Manufacturing Company that satisfactory progress had been made as far as the merchandise creditors are concerned, but only fair progress as to the stockholders. Both the merchandise creditors' committee and the stockholders' committee expressed confidence that if further time were granted they would be able to produce subscriptions for the $10,000,000 of new assenting stock. The readjustment committee, to enable the merchandise creditors' committee to complete such subscriptions, has therefore extended the time to produce such subscriptions to June 22. It is understood that unless subscriptions are furnished on that date no further time will be given to the merchandise creditors' committee or the stockholders' committee.

Electrical Notes from Europe.

(By Our Special Correspondent.)

A portion of the railroad which runs from Naples to Pompeii has been lately equipped for running trains on the electric system, using direct-current motor-cars working at 750 volts. The total length of the Naples-Pompeii Railroad is forty-three miles, and the present electric section is nineteen miles in length. The electric section was started running not long since, and has proved to be a success. The Westinghouse system is applied here. On the motor-cars, which are thirty-five feet in length, are mounted two 750-volt motors of fifty kilowatts. There are two trolleys placed on the car. At present the trains are made up of a motor-car in the front and rear, and five cars of the standard type for the body of the train, and the nominal speed is thirty-five miles an hour. In this case the controlling apparatus in each motor-car is worked separately, and to this end each motorman has an ammeter which is connected by cable passing through the train to the second motor-car, so that he can observe the current which is taken and regulate his speed accordingly.

A pair of apparatus for photograph transmission on Dr. Korn's system has been completed a short time ago at the Carpentier establishment in Paris. It includes all the most recent improvements and great care is given to the construction of the mechanical parts. Each apparatus consists of a transmitter and receiver which are worked by a synchronous motor. At each end is mounted a synchronism indicator connected with the other motor. The synchronism is carried out as usual by having one motor run slightly in advance of the other, with a stop and an automatic release at the end of each revolution. The transmitter has a vertical cylinder which receives the transparent photograph film containing the image, and the horizontal beam of light passes through each point of the latter and is sent up along the axis of the cylinder to a selenium cell. The essential part of the receiver is a galvanometer which receives the variable current from the line. Between the poles of the magnet is mounted a shutter for the light beam which consists of a small piece of metal foil placed at the centre of a stretched double wire, and it is deflected back and forth in a horizontal line so as to intercept the beam more or less. The latter is made to fall upon a cylinder which corresponds to the former one, and the photographic film mounted upon it receives the light. The cylinder is contained in a dark box which can be removed readily from the motor shaft. M. Carpentier states that the present apparatus is to be sent to an American journal.

The electrical exposition at Marseilles was opened last month and it will last until October. It occupies a large extent of ground lying on the Prado, which is one of the principal avenues in the outlying district, and lies near the sea. The principal buildings are of a handsome character and include the Grand Palace, the Energy building, Traction and Mines and Agricultural buildings. There is also a very interesting retrospective collection which shows the development of the industry. The exposition is intended to promote the use of current by the public in the cities and the populous regions in the south of France, and it is well attended by the public. One of the interesting features of the exposition will be the Electrical Congress which is to be held from the fourteenth to the twentieth of September. It will include general sessions, meetings of the sections, lectures and visits to industrial establishments. M. Mascart is one of the honorary presidents. There are nine general sections, comprising regulation, construction and protection of lines, operation, lighting, etc.: mines, traction and agriculture, electrochemistry and electro-metallurgy, telegraphs and telephones, measurements and education, and hygiene and electromedical work.

A single-phase electric line is to be constructed in the south of Italy from Salerno to Valle Pompeii, on the Westinghouse system. It will be a narrow-gauge track and will cover a distance of twenty miles. A substation is to be erected near the road which will receive high-tension, three-phase current from a distant plant and will have rotary converters for producing single-phase current at 6,600 volts and twenty-five cycles. This latter current will be sent directly into the trolley line, the latter being suspended on the simple catenary system. At present the road is designed to use twenty motor-cars, each of which will be equipped with two thirty-kilowatt motors.

The single-phase system is also to be used in France upon two lines which are in construction in the suburbs of Lyons. For the trolley wire a single-phase current at 6,600 volts will be employed, and the line will run fifteen motor-cars during the first period of operating. The cars will carry two thirty-six-kilowatt motors of the above type, which are built at the company's works at Havre. The total length of the two lines is about fourteen miles. A substation takes current at 600 volts direct current, and the converter group consists of a 220-kilowatt motor working at 450 revolutions per minute, coupled to a single-phase alternator of 225 kilowatts. The latter machine produces current at 6,600 volts and fifteen cycles for the line.

Recent figures show some interesting points as to the condition of the electrical industry in Germany as regards the imports and exports of electrical apparatus or material. The exports for the year 1907 are estimated at $45,000,000 in round numbers, which is an increase of 31.2 per cent over the preceding year. The imports are given as $2,600,000 only, and the great difference between the two figures is striking. This difference is not to be attributed to the new treaties of commerce, in all probability, but is no doubt due to the technical development of the home methods of manufacture and the satisfactory economic situation of Germany with respect to other nations. One reason for the increase of the exports no doubt lies in the fact that many of the leading houses have agencies in foreign countries.

The experiments which the Oerlikon Company has been making on the Lee-bach-Wittingen section with single-phase locomotives continue to be successful. It will be remembered that the overhead line is operated at 15,000 volts. According to the tests, it is found that a frequency of fifteen cycles is preferable to the fifty-cycle current which was used during the first period of the experiments. This is especially true as concerns the new series motor which uses a collector. The tests bore principally upon two locomotives, the first of these being a locomotive carrying two series motors of 200 horse-power. A

transformer is carried on the locomotive for lowering the voltage. The second locomotive is of another type, and also carries a transformer. In the present case two bogies, each carrying a 200-horse-power motor are used for the locomotives, with gears and driving bars which give a speed ratio of one to 3.1. The driving wheels have one metre diameter. The speed is regulated by using different sections on the transformer secondary and coupling these upon the motor by means of the controller, and the latter is operated by an electric method.

Not long since a new section of the Paris subway was opened for traffic and it is now running regularly. It is a part of the line which will run eventually across town from north to south, but it will be some time before the entire line will be completed, especially the portion which passes under the Seine in tunnel. The finished part of the subway runs from the Seine to the North Railroad depot. As to the work on the tunnel portion of the line under the Seine, the metallic caissons for the tunnel and the stations have been sunk in place for some time past, but the remainder of the work will take a considerable time to finish.

C. L. DURAND.

Paris, May 28, 1908.

Electrical Notes from Great Britain.

(From Our British Correspondent.)

THE Franco-British Entente-Cordiale Exposition was opened on May 14, the ceremony being performed by the Prince and Princess of Wales, to the accompaniment of massed bands, a solo by Madam Albani, and a drenching downpour from frowning heavens. Multitudinous umbrellas, much mud from unfinished paths, unopened packing cases, scaffoldings here and there—with all these and many other inconveniences, some of which might have been avoided by the management, while others could not, but all of which make a permanent impression upon one's mind, we opened the great unfinished show. The Briton claims it as his special privilege to grumble, and here was an opportunity just after one's heart. But the Franco-British sentiment is not to be damped by a downpour, nor the spirit of it diluted. The chief impression formed on the opening day was the bigness, variety and attractiveness of the whole undertaking from the general public point of view—when it is ready and when the sun shines, or the magnificent electrical illuminations are in evidence on a fine night. All London will be there many times during the season; our French friends are coming in great numbers and will continue to do so, but the Anglo-French spirit will not so pervade the place that we shall forget to give a right royal welcome to our cousins in the States when they come. We prefer not to say at this moment whether it will be worth while for an American engineer or electrician to come over to see the English and French engineering and electrical exhibits. Nobody who is coming on a pleasure trip at any rate will think of missing a day at Shepherd's Bush, and electrical men, if they are here in the month of October, can "do" both the Franco-British and the Manchester Electrical exhibitions.

Within the past month the London Electrobus Company has been before the investing public with a prospectus for raising new capital to enable it to put about 125 more electric omnibuses on the London streets. The directors considered that the results obtained from the working of the first instalment of these vehicles justified them in extending the service if they could get the public to find the capital. It is reported that in this they have now been successful, so presumably the Electric Vehicle Company will proceed to build and equip the new 'buses. The Electrobus Company has a contract with battery suppliers for the maintenance of the batteries (Tudor & Gould) at two pence per car-mile. Tire maintenance is also under contract. If the estimates of profits turn out to be in practice anything like they appear in this prospectus, shareholders will have little reason to grumble. One almost wonders why the public were let in at all with such brilliant prospects.

The report of the British Westinghouse Electric and Manufacturing Company refers to the institution of various economies throughout the administration, and says that the general volume of the company's business increased substantially in 1907. Though at the present the demand is slack, the company is stated, now that it has got through its financial anxieties, to be in an improved commercial position both at home and abroad, which will enable it to take advantage of any revival in trade. The trading profits for the year were $460,000, of which some $56,000 is carried forward after financial charges and depreciation have been provided for. J. A. Bryce, M. P., the chairman, says that a great improvement was shown both in the volume of orders and in the reduced cost of manufacture. The output per pound of pay-roll had steadily increased —with a two per cent lower pay-roll more than ten per cent additional value of apparatus was produced. Selling expenses were higher owing to an increase in office expenses abroad, but the percentage of cost of selling to the amount of orders booked was lower than in 1906. There was seventeen per cent advance in shipments. With a view to improved efficiency and economy in manufacture many lines of apparatus had been redesigned during 1907 in order to meet the severe competition at home and abroad. The export business had shown a considerable increase and new agencies had been established in various quarters of the globe. Several contracts had been taken on the Continent in co-operation with the French Westinghouse company.

Callender's Cable and Construction Company—among the most successful of British cable makers—alludes in its summary of last year's trade, to more difficult and less remunerative business than was experienced in 1906. The most pronounced factor in restricting business in heavy electric mains was the abnormal price of copper in the first eight months of the year, leading to the temporary abandonment of nearly all new enterprises in electrical supply, and to the curtailment of extensions of existing networks. Therefore only such work as was absolutely necessary was given out. The company has registered its German business under German laws with headquarters in Hamburg, and claims to have experienced excellent results from this step. The stringency of the money market hampered all electrical industry very seriously last year, and though there are signs of improvement it is thought by some electro-financial authorities that it will be some time yet before much capital can be raised for even the best electrical schemes. The National Electric Construction Company, which controls a number of lighting and tramway undertakings in this country, has just announced its decision not to distribute the $45,000 profits of the year as dividends, but to carry it forward, ow-

ing to the financial depression and its effect upon some of the company's schemes which have so far been delayed. A point of interest is that the Dolter surface contact tramway system which this company had put in at Mexborough is being superseded by the overhead trolley system owing to unsatisfactory experience. The Dolter lines at Torquay and Hastings are stated to be more satisfactory as they embody improvements which Mexborough experience has shown to be necessary. To carry out these improvements at Mexborough would have been too costly a matter so it was resolved to change over entirely to trolley.

Upon the death of Lord Kelvin the presidency of the Institution of Electrical Engineers was taken over for the remainder of the season by Colonel Crompton. The meetings are now practically at an end, and the new president nominated for the 1908-9 session is W. M. Mordey. As is usual toward the close of the session weekly instead of fortnightly gatherings have recently been held, and the latest subjects considered have been: "Recent Progress in Tungsten Metallic-Filament Lamps," by Hugo Hirst, of the General Electric Company, Limited; "Switchgear Control Apparatus and Relays for Alternating-Current Circuits," by Dr. C. C. Garrard, of Ferranti, Limited, and on "The Manufacture of Electrical Condensers," by G. F. Mansbridge, many of whose data were taken from the records at the post-office factory at Mount Pleasant. Among the subjects recently discussed by members of the London Physical Society may be named: "An Examination of the Formulæ for the Grading of Cables," by C. S. Whitehead, and "The Production of Small Alternating-Currents of Variable Frequency Suitable for Telephonic and Other Measurements," by B. S. Cohen.

On May 7 Lord Cromer's Select Committee of the House of Lords began its consideration of the several schemes that have been brought forward for supplying London and the district with cheap electricity. The "London and District" scheme, as it is termed, came on first and is still undergoing investigation as this is being written. H. F. Parshall and Robert Hammond have been giving expert evidence in its favor. It is practically on the lines of the Merz "Administrative" proposal of 1905 which nearly got through. The second scheme to be considered will be that promoted by a number of existing supply companies who seek linking-up powers, and there is a third in which two of the existing companies only are interested. It is unnecessary to detail these different proposals here for in a few weeks or less—perhaps before this is printed—one or two, or even all, may have been consigned to oblivion. There is little of exciting interest in the proceedings, indeed they may be described as "flat"; the reiteration of the same tale year after year is becoming wearisome, and it is greatly to be desired that some step forward may be taken, however small it be. The committee might do worse than allow the existing companies to try what they can do in the area with the Power bill sword of Damocles withdrawn. Exactly where the millions of capital would be subscribed from for a big new company at the present time when all electrical supply securities are viewed with little favor by the public, it is not easy to see.

The dinner of the National Telephone Company is an event of the year. In 1907 it had to be abandoned after the issuance of invitations owing to the death of W. E. L. Gaine, the manager. This year Albert Anns, the secretary, presided, and referred in the course of his speech to the failure of municipal telephony in the United Kingdom. For several years the company had been in the throes of conflict with various municipal corporations, especially those of Glasgow, Brighton, Tunbridge Wells and Swansea. For the municipalities the issue had been disastrous. Tunbridge Wells and Swansea had surrendered to the company and handed over their systems, while Glasgow and Brighton were the subjects of a governmental rescue. George Franklin, the chairman of the company, said that every eight years the "National" doubled itself. As the National undertaking is to be taken over by the government in 1911, that theme quite naturally came in for notice, both the gentlemen named above taking the opportunity of assuring the staff that their interests would be properly regarded in arranging the transference from the company to post-office control.

Sir Edgar Speyer had a sorry tale to unfold at the meeting of the Underground Electric Railways Company, of London, when the capital readjustment scheme was considered on May 11. For six years they had labored against adverse influences and disappointments in their efforts to afford the needed additional transportation facilities for the people of London. Municipal opposition, increasing constructional cost, unregulated and profitless motor omnibus competition, the cheap tram fares of the London county council, unfavorable money market, delays in completion of their systems; each of these was a responsible factor, and to them all have to be added the oversanguine estimates of experts who thought that London was going to do as New York and Chicago had done in regard to volume of traffic. Sir Edgar said that he did not wish in any way to minimize the mistakes and miscalculations. Their experts had been wrong—as experts often were. He holds that if they were properly co-ordinated the existing transportation facilities of London could be made to form the most perfect and expeditious system in the world, and a paying one. The financial scheme has now been approved and Sir Edgar describes the future as being not without promise.

The Marconi Wireless Telegraph Company is increasing its capital to $3,750,000 by the creation of $1,250,000 in seven per cent preference shares. This will enable engagements to bankers and others to be met, and then leave sufficient to extend the business, complete the long-distance stations and provide them with the necessary land-line facilities, etc. H. Cuthbert Hall is no longer managing director. Mr. Marconi will carry on the duties of that office, in addition to his scientific work, "until a suitable business manager can be found." Mr. Marconi has entered into a fresh agreement for a further three years as the company's technical adviser. In a speech to the London shareholders early in May he said that seven and one-half months' experience of the working of the transatlantic service confirmed his opinion that wireless telegraphy would be an economical method of communication with America and other far-distant countries. For some months past the majority of the messages across the Atlantic were sent during daytime, and the operation of the powerful land stations caused no interference whatever with the working of ship-to-shore stations. They had made no attempt at high-speed working. They had attained to twenty-four words per minute, and slight modifications of the apparatus could increase it to thirty. He had lately tested an improvement which made duplex working between wireless stations possible. He added that the Coltano high-power station in Italy would be completed by the end of this year.

ALBERT H. BRIDGE.

London, May 28, 1908.

CENTRAL STATION PRACTICE.

SOME PRACTICAL POINTS ELUCIDATED IN THE DISCUSSION AT THE RECENT CONVENTION OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

During the discussion of various papers bearing directly upon central station practice at the convention of the National Electric Light Association, Chicago, Ill., May 19-22, there were many little sidelights thrown upon the subject in the relating of experiences by practical men in charge of electric plants or concerned in the designing of apparatus for central station service.

In commenting upon the economy of operating in small stations, T. W. McNamee, Wabash, Ind., said he maintained a record which has been found to be of extreme value—this is an accurate daily record of the performance of coal in the way of evaporation. Originally it was tried to get this by using hot-water meters, but the hot-water meter was found to be very unreliable. Later the boiler feed-pumps were equipped with auxiliary pumps having exactly one-tenth the capacity of the main pump, and with this auxiliary water is pumped out of the cold-water tank through a small cold-water meter and back into the same tank again.

R. S. Searle, Rochester, N. Y., said that in order to get at the true economy in a boiler plant of a small central station, it is necessary to know the amount of CO_2 in the flue gases. It is therefore necessary to find out at what rate per square foot of grate you are burning a given coal, and as your load varies it is necessary to brick over the grate of the boiler in use, or the boiler brought into use on the peak demand, so that you are always burning the maximum number of pounds of coal per square foot of grate; this will give, under ordinary conditions, about nine per cent of CO_2 in the flue gases. Operating the full grate service on light loads, the CO_2 will fall to three or four per cent, practically heating the boiler with superheated air.

John Campbell, Boston, Mass., said that money spent on the consulting engineer is money very well spent. On the question of operating at 120 pounds steam pressure, if it is an old plant, and the existing boiler capacity is of that pressure or thereabouts, that is reason for it; but the trend to-day, and the proper trend, is toward high pressure. The engineer should have control over his fuel and should have sufficient initiative to complain of the quality of the fuel and insist that he shall receive fuel with which he can obtain the proper results.

As an indication of the value of graphic records in a commercial department, Theodore I. Jones, New York, N. Y., said that during the fall of last year, when the financial depression came, his company took its reports of cutouts and a map of Manhattan Island and plotted on that map a curve which showed where the business was lost and where the business was gained. In that way he could follow pretty closely what particular district needed the greatest attention by the soliciting department. In addition to the matter of cut-outs and cut-ins each particular agent at the time he turned in his contract also put in a daily report. In that daily report there were three columns: First, the business represented by sixteen-candle-power equivalents, whether it was new or what is called "successor"; second, whether it was a renewal of an existing contract, and, third, whether the man had ever used current before. In that way it was possible to keep a complete line of the class of business the agents got and credit them accordingly. As to the question of the graphical curve and its effect upon the force, it is interesting to note that toward the end of each month on this particular curve the business of the previous two years was plotted, and this proved a source of incentive to the members of the force to beat the previous two years' record, and toward the close of each month the men have on the bulletin board of the office this record of their daily work, the totals each day and the total consumers for the work of the month. They will often consult the graphical curve showing the magnitude of the business of the previous year, and if a little more hustling is necessary to exceed the results obtained in the previous year each man of his own volition takes it upon himself to increase the business and keep the last line on top.

T. T. Maxwell, Philadelphia, Pa., said that the aim of the commercial department should be to secure as much business as possible under such conditions that the customer will continue on the lines indefinitely, securing the business under such conditions that such percentages as forty-three lamps lost for every 100 lamps gained, which have been cited, shall be reduced to as low a figure as possible. The conscientious solicitor holds a responsible position. He is sent out by his company to lay its case before the public, and he should do it honestly, or there should be no place for him on the staff. The solicitor who brings in many contracts because he has made promises and guarantees to his prospect which the company later on finds difficulty in carrying out, leaves a trail behind him that it may take many months to counteract. In fact, his employer will never know the amount of damage he has done to the company's reputation. It has been the practice of the Philadelphia Electric Company to hold a general meeting once each month, which, while designated a managers' and solicitors' meeting, is by no means exclusive. The heads of other departments and as many of the rank and file of those departments are invited as care to come, and they are free to speak also, but the main work of writing and delivering papers is done by the solicitors themselves.

The matter of complaints is receiving a great deal of consideration. Farley Osgood, Newark, N. J., said that one of the greatest difficulties in the matter of complaint work is brought about by the representative of the company to whom the customer makes the complaint assuming there is no justifiable complaint. Better progress can be made with the customers by sympathizing with them and trying to see their side of the proposition, assuming that if there was no just ground for complaint that they would not make it.

Harold Almert, Wichita, Kan., said that in one company with which he is connected a majority of the help in the office were young men. An elderly man or woman coming into the office to make a complaint or to seek information is not inspired with confidence in approaching a young fellow, and he had found some changes very profitable. In that particular office a majority of the young men are still retained, but the chief clerk, whose desk is located so that he can watch each wicket in addition to attending to his general duties in taking care of the books, keeps an eye on the entire office, and whenever a customer approaches any window, if the clerk does not see the customer, immediately a buzzer under the window rings. The complaint desk was taken care of at first by a young man with a salary of $50 a month, who was selected because he had had practical experience, but it was soon found he was very arbitrary and that good judgment could not be secured from a young man of his age. It was found that by doubling the salary a man of mature judgment could be secured, and the change has paid wonderfully in that line.

The Rusting of Iron.

At the recent meeting of the Iron and Steel Institute, held in London, May 14 and 15, a number of reports were submitted upon the research work carried out on various metals during the year. The following abstract of the report submitted by Dr. J. Newton Friend, on "The Rusting of Iron," is of interest.

Several theories have been advanced from time to time in order to explain the fact that iron corrodes when exposed to the combined action of air and water. Of these the oxidation theory, which maintained that the action was a simple process of oxidation, is shown to be untenable by the fact, established by Dunstan and his co-workers, that liquid water is essential to the formation of rust. The peroxide theory of Dunstan, advanced in 1905, asserts that rusting takes place in three stages, which may be represented by the following equations:

$$Fe + OH_2' = FeO + 2H$$
$$2H + O_2 = H_2O_2$$
$$2FeO + H_2O_2 = Fe_2O_2(OH)_2 \text{ [rust].}$$

It will be observed that twice as much hydrogen peroxide is formed during the initial stages of the reaction as is required for the further oxidation of the iron. Nevertheless, Dony and A. Dony were unable to detect the presence of this substance during the rusting of iron, although they used an excessively sensitive photographic method.

Since the discovery of a bacterium, *Gallionella ferruginea,* which obtains its life energy by the decomposition of organic ferrous salts with the precipitation of rust, biologists have been led to suggest a theory, according to which the rusting of iron is attributable to bacterial agency. The author has proved, however, that iron will rust just as readily in carefully sterilized tubes as when exposed to the open air.

In 1903 Whitney proposed a very plausible theory, according to which the rusting of iron is due to the electrolytic action of water, the rate of corrosion being simply a function of electromotive force and resistance of circuit. Water, being dissociated into H° and OH′ ions, exerts a solvent action on the iron, owing to the formation of an electric current containing iron as the positive and hydrogen as the negative element. The ferrous hydroxide, $Fe(OH)_2$, thus formed absorbs oxygen from the air, and rust is precipitated.

In a recent communication to the *Journal of the American Chemical Society,* Walker, Cedarholm and Bent have vigorously supported Whitney's theory, and claim to have established the fact that iron dissolves to an appreciable extent in pure water, when every trace of oxygen and carbon dioxide has been excluded.

The present author has shown, however, that this solvent action was due to the presence of traces of carbon dioxide, which can not be expelled from water by the mere process of boiling, and the existence of which these investigators had ignored. The electrolytic theory of the rusting of pure iron is thus shown to be untenable.

The acid theory, apparently first suggested by Crace Calvert, has now to be dealt with. According to this theory the presence of traces of acid in water causes the solution of the iron in the form of a ferrous salt, which readily absorbs oxygen from the air. Rust is precipitated, and the acid set free to attack more iron. Thus a trace of acid is able to convert an indefinite quantity of iron into rust, provided oxygen and liquid water are present in sufficient amount.

Since carbonic acid is the most common acid in nature, the changes usually involved in the corrosion of iron exposed to the atmosphere may be represented by the following equations:

$$Fe + 2H_2O + 2CO_2 = FeH_2(CO_3)_2 + H_2$$
$$4FeH_2(CO_3)_2 + O_2 + 2H_2O = 2Fe_2(HO)_6 + 8CO_2.$$

The hydrogen gas set free combines with any dissolved oxygen to form water. Moody has recently lent strong support to this theory. By a very ingenious experiment he shows that rust is formed by the action of oxygen on iron already in solution, and not by its action on the metal itself. Moody has further succeeded in keeping a piece of pure iron in contact with pure air and water for several weeks without the formation of the slightest trace of rust. This result might have been accepted as final, had chromic acid not been used to remove carbon dioxide from the apparatus. There is evidence to show that chromic acid causes a thin film of oxide to form on the surface of the metal, and thus protects it from further attack. Moody's experiment, therefore, simply proves that pure iron, coated with a layer of oxide, is not attacked by pure water and oxygen.

The present author has therefore studied the action of water and air on pure iron, afresh, and the investigations have been extended to the behavior of wrought-iron, steel and cast-iron exposed to similar treatment.

It was found that steel and the purer forms of iron could be kept for an indefinite time in the presence of pure water and air without undergoing the slightest change.

The introduction of the merest trace of acid, however, caused immediate corrosion.

Cast iron, on the other hand, rapidly rusted in the presence of pure water and air, owing to the catalytic or electrolytic action of its numerous impurities.

It was further found that neither water and air nor steam and air, at 100 degrees centigrade, exerted any action on the purer forms of iron, though a layer of oxide was immediately formed on introducing a trace of carbon-dioxide.

It is well known that when iron has once begun to rust further corrosion proceeds rapidly. According to Kuhlmann this is due to the fact that the rust acts as an oxygen carrier, and catalytically assists in the oxidation of the unattacked metal. A second theory attributes the phenomenon to the hygroscopic nature of rust, whereby its pores become saturated with moisture charged with carbonic acid. Hence iron which has once begun to rust continues to do so in a moist atmosphere, where rust-free iron would not be affected. The present author has succeeded in preserving a piece of partially rusted iron in contact with pure air and water without the slightest increase in the rusted area being apparent, thus demonstrating the correctness of the latter theory.

The action of hydrogen-peroxide on the various samples of iron has also been studied. Pure iron was found to be unaffected by it, though the peroxide itself was rapidly decomposed. This confirms the earlier observations of Moody. Wrought iron, steel and cast iron were attacked to an extent proportional to the impurities they contained. Only cast iron was attacked by the peroxide in alkaline solution.

The neutral salts of mineral acids were found to exert a corrosive action on iron in the presence of water and air, quite apart from the presence of any carbonic acid which their solutions might have contained.

It is usually stated in text-books that powdered iron effects the decomposition of water at ordinary temperatures. The present author can not confirm this.

The author believes that the results recorded in this research point conclusively to the fact that the rusting of iron is primarily the result of acid attack.

Tungsten Lamps.

A great deal of consideration was given to the subject of tungsten lamps at the recent convention of the National Electric Light Association, Chicago, Ill., May 19-22. As usual, Dr. C. P. Steinmetz had something illuminating to say on the matter. In analyzing the characteristics of the tungsten lamp in comparison with those other forms of illumination with which it will naturally compete, Dr. Steinmetz said that the efficiency of light production in the luminous arc, whether of the magnetite, titanium or flaming-carbon type, or even the mercury lamp, was superior to that of even the tungsten incandescent lamp. It may be anticipated that none of the incandescent lamps can be expected to compete with the luminous arc in the matter of efficiency of production of light, but the superiority of the incandescent lamp for certain other frequent phases of outdoor illumination must be found in the superior proficiency of producing illumination as based on the ability of the incandescent lamp to be a smaller unit of light. The great handicap of the arc is that it is a large unit of light. Where, therefore, high brilliancy of illumination is required by the condition of the problem, as is the case in the interior of cities, the incandescent lamp will never be able to compete with the luminous arc. Where the intensity of illumination required is lower, there the incandescent lamp gains more by its efficiency in low units than it loses by being lower in the efficiency of light production than the luminous arc. Both illuminants, therefore, have very legitimate fields in which they can not be beaten by the other.

If the lamps are spread twice as far apart, one-fourth of the illumination is secured at the minimum point, but the relative comparison of economy remains the same.

The comparison of the relative costs of lamp-posts, etc., is an item which requires consideration, since the smaller units have to be placed very much more frequently.

Now, under these conditions of low brilliancy of illumination, in outlying districts, residential and suburban parts, the supply of current will practically always be overhead. Under the conditions assumed in the paper, we have about sixty incandescent units per mile, and nearly seventeen units of arc, and that means the average distance between the incandescent units is somewhat less than 100 feet, and of the arc units somewhat over 300 feet. The average spacing of the incandescent lamp is about of the same magnitude as the average distance of the poles of the light—that means, in the case of incandescent lamps, one lamp at every pole, and in the case of the magnetite or luminous arc one lamp at every other pole. In this case the smaller number of lamps offers no advantage in lessening the number of lamp-posts.

The greater number of lamp supports required for the incandescent units is probably compensated for by the greater strength required in the arc-lamp support due to the greater weight of the arc. So that in the case of low brilliancy illumination in suburban districts, the cost of lamp-posts, etc., would probably be about the same.

Going to higher intensity of illumination, an arc lamp would be placed at every second pole or every third pole; and with the incandescent unit there would be required two or three times as many lamp-posts as there are poles on the line. It means, then, in going to higher illumination intensity the incandescent lamp will increase in cost over the arc lamp by the greater number of posts required, if the lamps are spaced so as to get the same minimum illumination with single lamps at every post. Inversely, if the higher illumination is secured by having several lamps at each post, it merely means the loss of part of the advantage of the smaller unit. To get twice the illumination it requires forty-one more units, with one unit per post, and twice as many lamps if two lamps are put on each post; all the economy of the incandescent lamp is based on having a single lamp on every post, and as far as this can be carried out with a considerable spacing between the lamps, the incandescent lamp will have the field, owing to its better distribution of illumination.

We all agree that the price of the tungsten lamp now of necessity is high and will remain so for some time, but will not always remain so, and that any decrease of cost of the tungsten lamp must rapidly increase the economy of this lamp far beyond the values which it shows now. Taking the figures which are now given as standard, a decrease in cost of the tungsten lamp of somewhat less than thirteen per cent can be figured out, which would make the cost of illumination by the tungsten lamp less than the cost of carbon alone of the carbon-filament lamp, so that a drop in price of thirteen per cent would make it more economical to take out the carbon-filament lamps and throw them away and buy tungsten lamps.

One of the best contributions to the discussion of the policy of central stations with regard to the introduction of tungsten lamps was presented by M. S. Seelman, Jr., of the Edison Electric Illuminating Company of Brooklyn.

With the understanding that the supply of tungsten lamps would be, at least for some time, limited, and with the idea that it would be more profitable to utilize such lamps as could be secured in replacing gas illumination, thus adding to the revenue, rather than to place them in present sockets, where they would be likely to reduce current consumption, it was decided to organize a separate company to exploit the tungsten lamp, and especially the 100-watt lamp, among gas consumers.

The Tungsten Lamp Specialty Company was therefore formed with the clear understanding that it must carry itself and pay its own way. As it was exclusively gas burners this new company was after, it was deemed advisable to present to prospective customers a unit price covering a complete tungsten equipment, including wiring and the supply of appropriate fixtures, reflectors and lamps. It was not deemed wise for the company to do its own wiring, as the company preferred to avoid all complications with the local electrical contractors, and to rather secure their co-operation than their ill-will. Specifications were therefore drawn, covering wiring in molding for a minimum of four 100-watt lamps, not more than six lamps on any one circuit, with a separate switch for window lights and a switch for each store circuit, the contractor to hang fixtures which were to be furnished by the company. These specifications were submitted to all contractors in good standing in Brooklyn and resulted in the Tungsten lamp company securing a blanket price of $2 per outlet and fifty cents per switch. Types of single-light fixture were adopted which cost the company from forty-five cents up to $1.20, according to style and length of stem. The reflector adopted as a standard for general use was Holophane No. 7,391. The price of the 100-watt lamp when sold separately was fixed at $1.75.

The proposition the Tungsten lamp company advanced to the public was to supply a complete equipment (the minimum being four lamps) for $7.50 per outlet; including, as aforesaid, wiring, fixtures, reflectors and lamps. This price allowed about $2.50 per outlet for office and sales expense.

Five solicitors were employed and each one supplied with a sample kit consisting of a neat satchel, enclosing sample fixtures, reflectors and 100-watt lamp. These solicitors were instructed to let exclusive electric installations severely alone and to confine their efforts as far as possible to stores illuminated altogether by gas; but they were also permitted to solicit business in stores partially illuminated by electricity and partially by gas, provided they could put the gas out of business. Business was to be done as far as possible for cash, but instalments spreading payment over not more than six months might be accepted where credit was good.

The Tungsten lamp company has been operating on this basis for about seven weeks, and during that time it has secured fifty contracts covering the installation of 312 tungsten lamps. Of these, forty-two contracts replaced installations exclusively gas, while eight replaced gas in installations partially electric. The average number of lamps to an installation is not quite six. The majority of these stores are now lighted by tungsten lamps.

All customers were given the option of renewing burned-out lamps in their installations for $1.75 per lamp, or of having the company maintain their installation for thirty-five cents per month per lamp (which is a guarantee of five months' life). So far, fifteen customers with ninety-seven lamps have availed themselves of the maintenance proposition and the others have themselves assumed the life risk of the lamps.

On May 1 the Brooklyn Edison Company announced to the public its policy regarding tungsten lamps, and offered the 100-watt lamps at $1.50. The Tungsten Lamp Specialty Company on the same date also reduced its price to $1.50 and its equipment figure to $7.25 per outlet. The Tungsten lamp company has handled incidentally some sixty and forty-watt lamps, but its main effort is directed toward the sale of the 100-watt lamp.

Although in business such a short time, the company has been able to meet the financial requirements under which it was organized. It has not only been able to do the business outlined in the foregoing, thus securing a number of new customers for the Brooklyn Edison Company, without any expense to the company, but it can show a surplus over and above all expenses. It has also obtained considerable tungsten experience of value to the Brooklyn Edison Company.

FINANCIAL REPORTS OF ELECTRIC COMPANIES.

KANSAS CITY RAILWAY AND LIGHT COMPANY.

The report of the Kansas City Railway and Light Company for the month of April and eleven months ended April 30 shows April gross of $492,472; expenses, $267,657; charges, $151,016; surplus, $73,799, a decrease of $3,321 as compared with the same period of last year. The eleven months' gross was $5,620,390; expenses, $2,926,329; charges, $1,683,912; eleven months' surplus, $1,010,149, an increase of $29,425 over the same period last year.

DETROIT UNITED RAILWAY COMPANY.

The report of the Detroit United Railway Company for the month of April and four months ended April 30 shows April gross of $546,163; expenses, $350,426; charges, $134,249; April net, $195,737; other income, $4,998; April surplus, $66,486. This compares with $64,066 for the same period in 1907. The four months' gross was $2,049,991; expenses, $1,360,240; charges, $540,133; four months' net, $689,751; other income, $19,480; four months' surplus, $169,098.

BOSTON ELEVATED RAILWAY COMPANY.

The gross earnings of the Boston Elevated Railway Company for May increased 2.8 per cent over the same month of 1907. This compares with an increase of two and one-half per cent in April, a decrease in March of two and one-half per cent, in February a gain of five per cent, and three-quarters of one per cent increase in January. The actual gross earnings for May were $1,214,000, compared with $1,181,000 for last year, an increase of $133,000. Gross earnings for the fiscal year to end September 30 next will show the smallest expansion of any year in the company's history. For 1907 the fiscal year gross earnings showed an increase of 3.1 per cent. For the eight months ended June 1 the increase in gross has been something less than $150,000.

ELECTRIC PROPERTIES COMPANY.

The annual report of the Electric Properties Company, New York city, for the twelve months ended April 30, shows earnings of $280,671, and surplus after preferred dividend of $15,697. The earnings for the eleven months ended April 30, 1907, were $388,248. The organization, legal and general expenses for the year ended April 30, 1908, were $85,630. For the eleven months ended April 30, 1907, they were $104,744. The net income for the year ended April 30, 1908, was $195,041; for the eleven months ended April 30, 1907, $283,504. For the year ended April 30, 1908, the preferred dividend was $179,344, and for the eleven months ended April 30, 1907, $128,057. For the same period there was paid a common dividend of $120,000. The profit and loss surplus on April 30, 1908, was $49,575. The balance sheet shows assets and liabilities as follows: Assets (1908)—Cash, notes and accounts receivable, including balance due on subscriptions subject to call, $1,805,385; sub-companies (Westinghouse, Church, Kerr & Company), $7,000,000; investment securities, $1,299,204; total, $10,104,589. Liabilities—Common stock, $6,000,000; preferred stock, $3,920,000; preferred dividend payable, $134,815; surplus, $49,573; total, $10,104,589.

The American Institute of Chemical Engineers.

It has been determined to call a meeting for the purpose of organizing the American Institute of Chemical Engineers at the Engineers' Club, 1317 Spruce street, Philadelphia, Pa., June 22. The following programme has been arranged: At the morning session, beginning at 10.30 o'clock, the visitors will be welcomed by Professor Samuel P. Sadtler, after which Dr. Charles F. McKenna, chairman of the committee appointed at Atlantic City to formulate plans for the organization, will address the meeting on "The Justification of the Institute of Chemical Engineers." Committees will then be appointed on plan and scope, organization, nomination of officers, etc., and a recess taken until the afternoon.

At the afternoon session, beginning at 3.30 o'clock, reports of the committees will be heard, and action will be taken thereon.

The election of officers and the perfection of the organization of the institute will take place at an evening session. Short addresses by eminent chemical engineers will be made during the evening.

W. M. Booth, Dillaye Building, Syracuse, N. Y., is acting secretary.

Civil Service Examinations for New York State and County Service.

The New York State Civil Service Commission will hold examinations on June 27 for the following positions: Architectural draftsman, $1,200 to $1,800; engineering draftsman (railroad and concrete work), $1,200 to $1,800; structural draftsman, $1,200 to $1,800, and junior draftsman (engineering and structural), $720 to $1,200.

RECENT PROGRESS IN TUNGSTEN METALLIC-FILAMENT LAMPS.[1]

BY H. HIRST.

The author introduces his paper with a brief historical sketch of the evolution of the incandescent lamp, attention being called to the various attempts to employ a metallic filament in place of a platinum filament. He then turns to the more recent work in developing the metallic-filament lamp.

When the carbon incandescent lamps were first introduced they had to compete with the flat-flame gas burners, and a glance through the earlier estimates of the comparative costs of electric and gas lighting shows that these gas burners were then considered as the standard illuminant. With the high price of electricity it was the very great convenience, beauty and safety of the carbon lamp which enabled electric lighting to make the progress it did. As this price of electricity was lowered with extended use, the carbon lamp had to face a much stronger competitor.

The incandescent gas mantle invented by Auer von Welsbach suddenly reduced the cost of gas lighting to one-third of what it had been before. Electric lighting has survived this blow and made progress, but this progress during the last ten years has been severely handicapped by the cheapness of incandescent gas lighting.

It is worthy of note that a considerable number of gas engineers considered that Welsbach mantles would ruin their undertakings because they reduced the consumption of gas for a given amount of light by one-third. Sufficient time has now elapsed to show how absurd their prophecies were.

It is of far greater interest to electrical engineers to know that Auer von Welsbach by his invention of the osmium lamp has removed the handicap which he placed on the electrical industry. Thus what he has taken away with one hand his inventive genius has enabled him to return with the other.

The existence of incandescent gas lighting has not only had a damaging but also a stimulating influence on the development of electric lighting. The quiet peculiar radiation of the incandescent gas mantle, which, as is well known, consists of thorium oxide containing one per cent of cerium oxide, has been the subject of numerous researches which have furthered the purely theoretical knowledge of radiation. Very careful experiments, especially the now famous investigations of Lummer, have shown that bodies exist which at the same temperature radiate as light a larger percentage of the supplied energy than the so-called "black bodies." The Welsbach mantle owes its high efficiency to this property.

The success of these oxides of the rare earths in gas lighting led to their application to electric lighting, as has been done in the Nernst lamp. The first English patent for this lamp was applied for by Nernst[1] on August 23, 1897, and in one of the claims it is stated that:

"A body of magnesia, zirconia, or suitable rare oxide is heated to incandescence by a Bunsen gas flame or otherwise and is then kept incandescent by the passage of electric current through it."

It is interesting to note that Nernst was endeavoring to dispense with the vacuum, which, of course, would have been an eminent advantage. The chief drawbacks of this lamp are that it requires separate means to heat up the glower in order to render it conductive and also a series ballast resistance. This lowers its economy, and without this resistance the glower can not be safely used.

There have not been any other important adaptations of the use of oxides for incandescent lighting, and it is to the metallic filament that we must turn for those inventions which are enabling electric lighting to compete with the Welsbach gas mantle.

The first commercial metallic-filament lamp was the osmium lamp, invented by Auer von Welsbach in 1898, and put on the market in the following years. Its regular commercial supply commenced in 1902.

In this lamp the filament is made of metallic osmium, which has a considerably lower specific resistance than carbon. Due to this increased conductivity doubts were expressed as to whether osmium lamps could be manufactured for the usual voltages.

The osmium lamp consumed per candle-power one and one-half watts; useful life over 1,000 hours; decrease of candle-power during that period scarcely any. They were hence much superior to carbon lamps taking per candle-power three and one-half watts, and after a life of 800 hours decreasing in candle-power twenty per cent.

At first the osmium lamps could only be produced for thirty-seven volts, which necessitated the connection of three lamps in series on a 110-volt circuit. The lamps were very fragile, and had to be burned in a perpendicular position. Their cost was about ten times that of a carbon lamp, due largely to the limited quantities of osmium available.

This did not prevent millions of these lamps being manufactured, but it was evident that it would be impossible to produce them in the quantities required to supply all Europe, which would need between thirty and forty million lamps per year.

During the following three years the osmium lamp was further improved and made available up to seventy-seven volts, enabling two in series to be used for 110 volts, and three in series for 220 volts.

In January, 1905, shortly after a paper read by Drs. von Bolton and Feuerlein,[1] the tantalum lamp appeared on the market. It possessed the great advantage that it could be burned in any position and on a 110-volt circuit. Its economy was slightly less than that of the osmium lamp, and the useful life of the filament was considerably shorter. It was found that this life, when the tantalum lamp was used on alternating-current circuits, was so low that the makers did not recommend their lamps for these circuits. It must, however, be said that in spite of this disadvantage the tantalum lamp would have been looked upon as the lamp of the future had there not been a serious competitor to it even before it was a commercial article.

Many inventors had been working independently on the improvement of the electric incandescent lamp, using metals with high melting-points, such as osmium, chromium, molybdenum, tungsten, etc., and it is interesting to note the various suggestions as to methods of manufacture which appear in the patent specifications.

Thus, Lodyguine[2] proposed to coat a suitable core of platinum, silver or carbon with these metals, but he could not obtain incandescent bodies consisting of the pure metals of high fusing-points, as evidently he did not know how to eliminate the interior core of platinum, silver or carbon on which the filament was built up.

The superiority of tungsten over other metals such as osmium, molybdenum, chromium, zirconium, thorium, tantalum, vanadium, niobium, etc., for the construction of incandescent filaments has now been ascertained by research, but was not proved at the time when Lodyguine made his investigations.

In 1904 Siemens & Halske[3] endea-

[1] From a paper read before the Institution of Electrical Engineers of Great Britain, May 21.

[1] British patent No. 19,427, 1897.

[1] *Electrotechnische Zeitschrift*, January 26, 1905.
[2] U. S. patent No. 575,002.
[3] British patent No. 20,277, 1904.

vored to extend their drawing process, which had been successful with tantalum, to tungsten, thorium, etc. The brittleness of tungsten and its want of ductility rendered the process inapplicable, and apparently Siemens & Halske have not up to the present time succeeded in producing lamps with drawn tungsten wire.

It was also in 1904 that Drs. Just and Hanaman[1] applied for a patent for incandescent bodies consisting of pure tungsten. This is the first English patent describing the manufacture of pure tungsten filaments—all previous inventors had failed to produce metallic bodies from this element which were free from oxides, carbon or carbides.

The second claim of their patent reads:

"Process for the manufacture of incandescent bodies in accordance with Claim 1, characterized by the fact that tungsten or molybdenum or compounds of these metals are mixed with organic binding media, formed and carbonized, whereupon the carbon is chemically eliminated, substantially as described."

Quite independently of these inventors, the Deutsche Gasglühlicht Aktiengesellschaft (the Auer company) applied for a patent[2] which covers a process for the manufacture of pure tungsten filaments. In 1906 and 1907 a large number of British patents were granted both to the Deutsche Gasglühlicht Aktiengesellschaft and to Drs. Just and Hanaman, which describe further improvements in the manufacture of tungsten filaments.

The two patents above mentioned cover what is known as the "paste" process of producing tungsten filaments—another method called the "coating" process was protected by Drs. Just and Hanaman in their British patent No. 11,949 of 1905.

These fundamental patents appear to protect the processes according to which tungsten filaments can be manufactured commercially at the present time.

Before passing on to the details of manufacture, mention is made of the patents of some other inventors. Among these are:

Heany (American patent No. 839,585), who proposes to use an alloy of tungsten with titanium.

Kuzel (British patent No. 28,154 of 1904) suggests the manufacture of glowing bodies from colloidal metals.

British Thomson-Houston Company (British patent No. 18,749 of 1906 and subsequent patents) describes the manufacture of filaments of tungsten with the help of volatile metals or alloys, chiefly amalgams, which could be drawn into wire. It will be interesting to watch the progress of this suggestion.

Zerning (British patent No. 2,554 of 1906) claims the use of hydrogen and nitrogen compounds of tungsten as the materials from which to construct tungsten filaments.

As far as the author knows, the hydrogenous compounds of tungsten have never been described by a chemist, and from the information he has been able to obtain the statement of Sir Henry Roscoe still stands. In his famous work, "Elements of Chemistry," he refers to the treatment by Berzelius of tungsten trioxide in a current of hydrogen.

The author understands that the result of the experiments of this famous scientist, which were confirmed by his French contemporary, Moissan, was the production of nothing but pure tungsten powder without any trace of hydrogenous compound being formed.

As Zerning's experiments were directed toward the same object, it would denote a wonderful achievement if he should have produced a result which is not described in any scientific work and which the above eminent authorities found to be impossible.

The nitrogenous compounds are well known, and it is proved that they can not exist at the high temperature at which the filaments have to be burned. The patent description is not very clear, but indicates that Zerning intends to make use of the "paste" process, thus producing filaments containing probably carbon or carbide.

After a careful consideration of all the patents on the subject, the author believes he is right in maintaining that of the multitude of processes that have been applied for and tried since the first application of the Deutsche Gasglühlicht Aktiengesellschaft and the Just and Hanaman patents, these two alone have during the last two years produced to the world commercial and useful lamps. By this he means lamps of such characteristics as regards current consumption, life and light as to inaugurate a new epoch in the electric lighting industry.

It has been ascertained that all metallic filaments burning at a consumption of one watt per candle have been made with tungsten filaments. If ever so small percentages of other substances are added to the tungsten, the economy and useful life of lamps with such filaments suffer immediately.

"Osram" is the name under which the Auer company introduced the first commercial tungsten metal-filament lamp.

The osram lamp is manufactured by the "paste" process, the principle of which consists in preparing from solid substances, such as the metals themselves, in the most finely divided form, a paste with binding or stiffening agents such as the gums, dextrine and other similar bodies. Such a mass has the consistency of putty, and is then squirted through a very fine orifice in a diamond, with a pressure of several tons per square inch. The result of the squirting operation is that one obtains a somewhat moist thread, which, however, has enough coherence to be formed into filaments that do not break while being dried.

The filaments are first heated under exclusion of air and then possess sufficient strength to be held in metal clamps. They are then subjected to the passage of an electric current which raises them to a high temperature, causing the filaments to sinter. The process of sintering is carried out in gases which chemically attack all the constituents of the binding agent, without the metal being affected, so that eventually a filament of pure metal remains. This filament is dense and homogeneous, but being obtained by a sintering process it is different in structure from the still denser metal which would be obtained from a melted mass.

Auer von Welsbach[1] describes a method for the manufacture of an electrical illuminating body of osmium by sintering the most finely divided metal at such a high temperature that platinum would evaporate, which temperature destroys the binding material which had been used in the manufacture of the threads. The filament so obtained withstands a very high temperature, but it is still of a more or less spongy or porous constitution; very metallic, but nearly solid. The difference of the filament of the osram lamp, which is pure tungsten metal, from the filaments of the osmium lamp, shows itself by the following characteristics: Owing to the higher melting-point of tungsten, an osram filament will stand a temperature at least 100 degrees centigrade higher than the osmium filament. Their specific resistance and resistance coefficients differ and there is considerable difference in their radiation properties. The color of the osram filament is a steel to a silver gray, while the osmium filament has a bluish-gray appearance.

When preparing osram filaments for

[1] British patent No. 23,899, 1904.
[2] British patent No. 19,379, 1905.

[1] British specification 1,535 of 1898, and German patent 138,135.

lamps of 120 volts, twenty-two to twenty-seven candle-power, burning at an efficiency of about 1.1 watts per candle-power, taking 0.2 to 0.25 ampere, the diameter of the filaments is 0.03 millimetre. The jet from which this filament is squirted is, of course, much larger. As an example:

The diameter of the jet at point of issue from the diamond is about	0.055 mm.
The thread, after being squirted, shrinks to, when dried	0.050 "
After it has been heated to a red heat under exclusion of air, it becomes a very porous filament, with a diameter of	0.045 "
When this is sintered by the passage of an electric current which raises it to the brightest white heat, its length is reduced, and it finally shrinks down to a diameter of	0.030 "
The shrinkage is caused by the removal of the carbon and other material forming the organic binding medium, which originally amounted to	84 per cent of the volume of the paste.
It follows that during the whole process 84 per cent of the original volume must disappear, and the shrinkage corresponds to a linear contraction of	55 " "

It is easy to alter the amount of shrinkage by selecting suitable proportions of the binding medium or by adding volatile substances which disappear on heating.

During this heating process the filament is fastened in clamps and placed in globes or other arrangements containing certain gases. The heating is effected by the electric current to a gradually increasing amount, and while the thread decreases in length and diameter, it at the same time allows the passage of increased currents. This is due to the sintering of the particles and also to the filament being freed from carbon, which even in minute quantities increases its resistance. The process is controlled by the operator, who has a voltmeter and ammeter to guide him. The current increases rapidly at first, but reaches a constant value within a few minutes. This is common to all sintering processes, and the same phenomena are observed with osmium, iridium or molybdenum filaments.

The filament so obtained is elastic but brittle, that is, the osram thread, 0.03 millimetre diameter, can be bent into a loop of about one centimetre diameter without breaking. After this bending it returns to its original form. Each filament is fastened on to its leading-in wires without the application of any paste.

This is carried out in the following way: The end of the leading-in wire is melted down to a small globule by means of an electric arc. This globule holds the filament securely, and the resistance from the passage of the current from the leading-in wire to the filament is negligible. The evacuation of the lamp is carried out in the same way as with carbon-filament lamps. Any process, mechanical or chemical, is suitable, but it is found that any traces of the gases occluded in the tungsten filament escape much more slowly than in the case of the carbon filament. The result is that the evacuation process requires a longer time with the osram than with the carbon filament lamp.

The other method of constructing tungsten filaments was developed by Drs. Just and Hanaman simultaneously with, but quite independently of, the Deutsche Gasglühlicht Aktiengesellschaft. Their lamp was introduced commercially under the name "Just-Wolfram." They use what is known as the "coating process," as described in the British patents 11,949 of 1905 and 3,684 of 1906. This interesting process is carried out as follows: Ordinary carbon filaments of very small diameter, 0.02 to 0.06 millimetre, are raised to a bright red heat by means of an electric current in an atmosphere of volatile tungsten compounds in the presence of hydrogen. The compounds most used are the chlorides and oxychlorides of tungsten.

The heat of the filament causes the hydrogen to reduce the volatile metallic compounds, depositing the metal in homogeneous condition on the carbon filament.

A later patent discloses a process whereby three or more filaments are coated in series at one operation. After the filaments have been coated in this way their transformation into pure tungsten filaments is carried out as follows:

The filaments are submitted to the action of an electric current in an atmosphere of highly rarefied inert gas, such as, for example, hydrogen at a pressure of about twenty millimetres, until they show the clearest white incandescence. This process causes the carbon to combine with the tungsten surrounding it, forming a carbide. This change is so complete that in the resulting filament the cross-section is tubular, and no carbon can be distinguished under a microscope at the point of fracture. The filaments so obtained containing carbon (mostly as carbide) present a glittering white metallic appearance.

In the next process they are raised to a high temperature through the passage of an electric current while they are surrounded by a mixture of hydrogen and a little steam. This causes the carbon to be oxidized by the same reactions which go on in the water-gas process. The carbon may, however, be eliminated by any other method which gives a resulting filament entirely free from carbon. Further improvements of this process, first described in the British patent 11,949 of 1905, have been disclosed in the British patent 3,684 of 1906.

Drs. Just and Hanaman have also obtained patents[1] protecting the process of mounting their tungsten filaments to the leading-in wires. This is effected by means of a paste consisting of finely divided tungsten metal mixed with coal tar or gum. These paste mounts are dried and finally made red-hot by any suitable means before the filament is heated in the bulb.

The supports used in these lamps are made of suitable metal.

Exhausting is done in a manner similar to that employed for carbon lamps.

The filaments made by this process have a light gray silvery appearance and a little smoother surface than those made by other methods; in fact, they most nearly approach the appearance of a drawn wire.

Though this process is entirely different from the "paste" process, the final result in each case is a pure, sintered filament of tungsten metal. The sole difference is that the filament made by the Just and Hanaman process is tubular. As regards economy, the tungsten or osram lamps produced by either of the above-described processes have identically the same characteristics.

It has been proved that these lamps will burn for from 1,000 to 2,000 hours with a consumption of about one watt per candle-power, without any appreciable falling off in the candle-power. Of all the metals which have been experimented with up to now, only pure tungsten has such a life.

In economy, the result is also better than has been obtained with other filaments, thus:

The osmium filament takes 1.5 watts and the tantalum 1.7 watts for direct current, and somewhat more for alternating.

OUTPUT AND EFFICIENCY.

In the following comparisons between the osram and carbon lamps the author has adopted the Hefner candle-power in every case, as this has so far been the standard mostly used when metallic filament lamps have been discussed. At the present it is found next to impossible to try to standardize metallic-filament lamps per candle-power. It would make the lamp commercially impracticable.

The metallic-filament lamps resemble in characteristics more the incandescent gas

[1] British patent 9,349 of 1906.

mantle than carbon-filament lamps, and there is, therefore, nothing unreasonable in demanding a similar treatment for them as is accorded to the incandescent gas mantle. The normal efficiency of both osram and Just and Hanaman lamps of all voltages is about one watt per candle-power. At such efficiencies they burn 1,000 hours without a perceptible decrease of candle-power.

The following figures give a comparison between the energy taken and power radiated from the surfaces of osram and carbon filaments:

The filament of a twenty-five-candle-power osram lamp, consuming per mean horizontal candle-power 1.1 watts, has a total surface of about fifty square millimetres, which equals per candle-power two square millimetres, or per watt of supplied energy, 1.8 square millimetres. A good surfaced carbon filament consumes per mean horizontal candle-power 3.5 watts = per candle-power 5.5 square millimetres, or per watt of supplied energy 1.57 square millimetres. It results, therefore, that one square millimetre surface of osram filament gives 0.5 candle-power and consumes 0.55 watt. One square millimetre surface of carbon filament gives 0.182 candle-power and consumes 0.63 watt.

surface. On the other hand, considering the greater light emanating from the osram filament, it ought to exceed the carbon filament by about 200 degrees centigrade.

These contradictory conclusions show clearly how different is the radiating power of the osram filament as compared with the carbon filament. The latter behaves much more like the "black body" of the radiation theory.

From approximate calculations the temperature of an osram filament burning at

TABLE I.

	Osram. Per Cent.	Carbon. Per Cent.
Increase of light due to 10 per cent increase in voltage.....	36	84
Decrease of light due to 6 per cent decrease of voltage....	21	34

1.1 watts per candle-power is about 250 degrees centigrade higher than that of a carbon filament burning at 3.5 watts per candle-power. If a carbon filament were to be overrun to such an extent as to consume only 1.1 watts per candle-power, its temperature would then have to be raised by 360 degrees centigrade.

The favorable radiating properties of the osram filament, therefore, mean that its temperature is 100 degrees lower than

tungsten filaments at ordinary temperatures, the resistance at those temperatures which, in a vacuum, correspond to 1.5 watts per candle will be as follows:

For a carbon filament, 0.55 of the original;

For a tantalum filament, 5.7 times;

For an osmium filament, 8.5 times;

For a tungsten filament, 11 times the original.

At temperatures of about 2,200 degrees centigrade absolute, each increase of temperature of ten degrees increases the resistance of a tungsten filament about 0.45 per cent.

If the pressure is raised from 100 to 104.5 volts, the current rises from 1 to 1.027 amperes.

For a carbon filament the amount of the increase would be from one to 1.05 amperes.

The total energy supplied, therefore, rises in the former case about 7.3 per cent, and in the latter about 9.7 per cent.

Near the normal conditions the light of a carbon-filament lamp rises and falls with the 6.3 power, that of a tungsten-filament lamp with the 3.6 power, of the voltage.

The latter differences are too great to be explained by the increase of energy caused by the change of pressure.

TABLE II.

LIFE-TEST RESULTS.

No. of Test.	Type.	Cost per Lamp. Pence.	Tested by	Starting. Watts.	Starting. Candle-Power.	Efficiency in Watts. Candle-Power.	Number of Lamps	Duration of Test. Hours.	Average Useful Life. Hours.	Mean Efficiency, Watts. Candle-Power.	Average Candle-Power-Hours.	Cost per 1,000 Candle-Power-Hours. Renewals. Pence.	Energy at 4 Pence per Unit. Pence.	Total. Pence.
	Low Voltage.													
I	Osram	48	Faraday House.	35.7	36.3	0.99	12	2,000	1,520	1.12	48,700	0.98	4.48	5.46
II	Osram	48	Westminster Testing Laboratory	35.8	29.7	1.22	12	1,500	1,360	1.29	36,600	1 31	5.15	6 47
IIa*	Osram	48					12	3,350	2,850	1.42	70,800	0.67	5.68	6.35
III	Osram	48	T. R. Charlottenburg	34.7	1.0	1.12	..	1,000	1,000	1.11	31,100	1.54	4.44	5.98
IV	Osram	48	Robertson, E. L., Ltd.	35.0	27.7	1.26	6	1,800	1,720	1.36	45,600	1.06	5.04	6 50
V	Wolfram	48	Robertson, E. L., Ltd.	38 0	30.7	1.24	2	1,000	1,000	1.27	28,900	1.66	5.08	6.74
VI	Tantalum	33	Westminster T. L.	39.1	22.0	1.78	6	1,000	700	1.84	15,000	2.19	7.36	9.55
VII	Carbon	12	.....	59.0	18.7	3.15	10	1,000	1,000	3.25	18,000	0 67	13.00	13.67
	High Voltage.													
VIII	Wolfram	90	Robertson, E. L., Ltd.	63.4	53.7	1.18	10	880	720	1.12	42,500	2.12	4.48	6.60
IX	Carbon	12	.....	68.0	18.9	3.6	10	1,000	1,000	3.95	18,200	0.66	15 80	16.46

NOTE.—For the purpose of comparison *all* the above results have been expressed in terms of the "Hefner" unit of candle-power.

*This is a continuation of Test II to 3,350 hours to show that it pays to burn osram lamps to the limit of life.

RADIATION.

It will be seen from the above figures that the osram filament radiates only eighty-seven per cent of the energy radiated by an equal surface of the carbon filament, but gives 275 per cent of the light given by the carbon filament.

If the kind of radiation were the same in both cases the carbon filament ought to get hotter than the osram filament by about sixty degrees centigrade, because of the higher total radiation per unit of

that of a carbon filament of the same efficiency. If it were not so possessed of this radiating property it would have to be burned at an efficiency of 1.5 to 1.6 watts per candle-power, in order that it might have the same life it actually possesses at 1.1 watts per candle-power.

A further favorable property possessed by all tungsten filaments is their high positive temperature coefficient of electrical resistance. If one takes the resistance of carbon, tantalum, osmium and

The small changes in the light of the osram lamp, as compared with a carbon lamp for the same change of voltage, can only be completely explained by the supposition that with a change of energy the radiated light is altered in a different way with the two lamps. A simple calculation shows that near the normal efficiency the light of a carbon lamp changes with the third power of the energy, while such change for an osram lamp progresses with 2.3 power of the energy. These propor-

tions have a very important practical consequence, which is clearly shown by Table I.

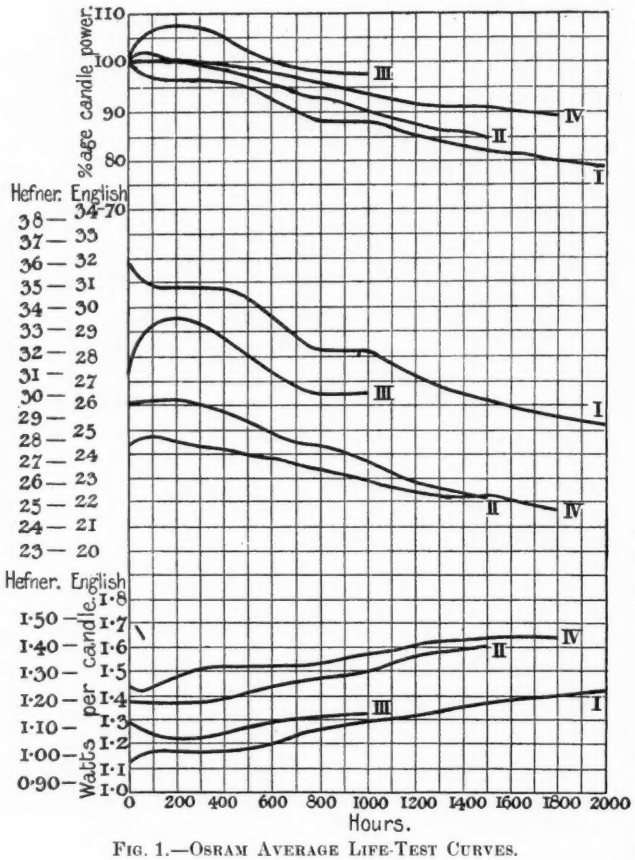


Fig. 1.—Osram Average Life-Test Curves.

It will be seen that the osram lamp is much less affected by changes in voltages. Thus, if the pressure is decreased by six per cent from the normal, the light from a carbon-filament lamp is reduced so much that it is a considerable drawback, while the reduction of light from the osram lamp is not considerable.

The use of the present types of tungsten lamp on high-voltage circuits requires that they be operated in series. For this purpose careful selection and pairing of units is necessary. The osram works do this, lamps being sorted out in from five to seven series numbers, the current being tested to one-hundredth of an ampere. This pairing can, of course, be avoided by the use of transformers of various types when the supply is by alternating current.

Regarding the effect of metallic-filament lamps on supply systems, the author thinks that this will first increase the unit of illumination, making it a twenty-five or thirty-five-candle-power lamp. Hence, there will be no decrease in the output of the central stations, but the comparative reduction in the cost of lighting will lead to a great increase in the use of this form of lighting. The first cost of these lamps is a drawback at present, but the author expects a considerable reduction in this direction very shortly. The problem of handling and shipping the lamps without excessive breakage has, he thinks, been solved satisfactorily.

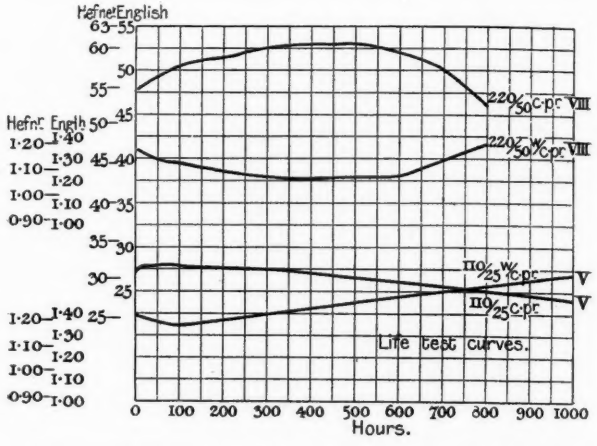


Fig. 2.—Test of Tungsten Lamps Made by the Just-Hanaman Process.

The table herewith and the accompanying curves show the average performance of various types of lamps. Fig. 1 gives curves for osram lamps, details of the lamps being given in Table II. Fig. 2 gives results of tests of tungsten lamps made by the Just-Hanaman process, which indicates the good quality of these lamps.

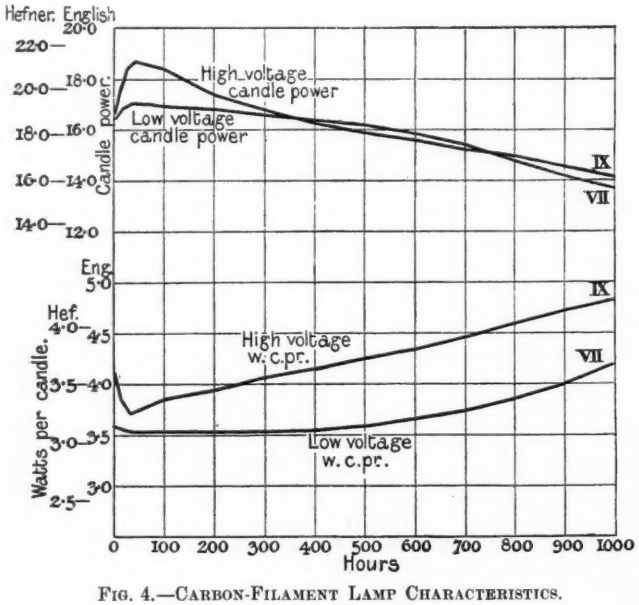


Fig. 4.—Carbon-Filament Lamp Characteristics.

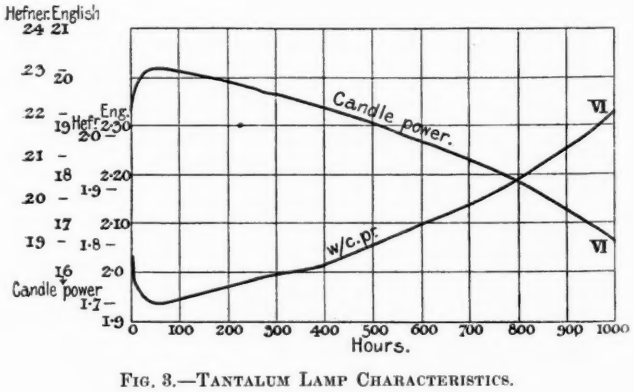


Fig. 3.—Tantalum Lamp Characteristics.

The test was stopped at 1,000 hours, but the lamp would probably have lasted for 2,000 hours or more. After 1,000 hours the drop in the candle-power was only three per cent.

Fig. 3 gives the results of a life test on tantalum lamps. This is a typical performance on a direct-current circuit. The author figures that for these lamps the cost per thousand candle-hours is

seventy-three per cent more than for the osram lamp. In Fig. 4 curves are given showing life tests of typical English carbon lamps.

Osram lamps have been used for street lighting in Canterbury, and the record of the performance there is given. Sixteen lamps burning in St. George's Place have had an average life so far of 1,834 hours. Eight of these lamps are still in service after 2,434 hours. On Dover street and Oaten Hill twenty-nine lamps have been in use, with an average life of 1,792 hours; of these fifteen were in service at the time of the report, having lasted 2,464 hours.

The author then considers some special applications of low-voltage osram lamps, and the use of these with small transformers. He discusses the losses taking place in the latter apparatus and assumes that the total transformer loss during the year for a 300-watt transformer would be forty-four kilowatt-hours; for a 750-watt transformer it would be eighty-eight kilowatt-hours. Taking the former figure and assuming a cost for energy of eight cents per kilowatt-hour, the cost of lighting a house equipped with twenty-five sixteen-candle-power lamps, nineteen of which are burning at one time, is worked out for various maximum hours of load. Assuming 300 hours at maximum load, he finds that the cost of energy with osram lamps would be $11.25; with carbon lamps it would be $28.50, a saving, by the use of the former, of $17.25. Assuming 800 hours of maximum load, the cost of energy for the osram lamps comes out at $23.85; for carbon lamps it would be $76. The saving, if the osram lamps be used, would be $52.15. In the first case the cost of renewing the osram lamps would be $7.50 Carbon lamp renewals would cost $1.75, making a total cost of the osram lamps of $18.75, and of carbon lamps, of $30.25. The total saving in the use of the osram lamps for 300 hours' maximum use would therefore be thirty-eight per cent. If the number of hours of maximum use were 800, the osram lamps would cost about $20 for renewals, and the carbon lamps, about $3.75. In this case the saving with the use of the former lamps would be forty-five and one-half per cent.

The author also calls attention to the reduced copper losses and the reduced size of transformers needed when the new types of lamps are employed. The saving due to the former item is found to be considerably more than would be expected. A difficulty has been encountered in the use of the small transformers, since the power taken by them when unloaded is not sufficient to operate the meter; therefore this is not recorded. This objection can be overcome by allowing the station to charge the consumer at a flat rate for such losses, which can be done very equitably.

A Rectification Effect in a Vacuum Tube.

A discussion is given in the June issue of the *American Journal of Science* of the behavior of the vacuum tube as a rectifier, which was noticed and investigated by Professor Henry A. Perkins. He found, in the first place, that when an exhausted tube, the pressure in which was about half a millimetre of mercury, was exposed to an alternating electrostatic field of low frequency and comparatively low potential, an ionizing effect took place which caused a direct current to flow through a suitably connected galvanometer. The effect was studied by making a tube perfectly symmetrical with electrodes in each end, which were connected to the galvanometer terminals. Over the tube was placed a metal ring which could be moved from one end to the other. The tube was about twenty centimetres long and two centimetres in outside diameter. The ring surrounding it did not touch it at any point, but was connected to one end of the step-up coil of a transformer, the other end of which was earthed and the low-tension coil of which was connected to the commercial supply. As soon as the primary coil of the transformer was closed, a faint glow was noticed in the tube about the ring, and the galvanometer was deflected, taking a fairly constant position. This deflection varied with the potential, but when the potential of the ring was less than 550 volts, it was not readable. The same was true if the ring was placed so that the glow did not reach to both electrodes. As the ring was moved from one electrode toward the other the current in one direction gradually increased, reaching a maximum near the centre of the tube. It then rapidly reversed to an equal maximum in the opposite direction and fell off, giving a symmetrical curve. When the ring was at either end of the tube the current was practically zero. It was difficult to obtain readings at points between the two maxima, as the effect here seemed to be unsteady, but at the maximum points and beyond the readings were quite steady. A more careful exploration of the curve showed peculiar humps and notches in it at the highest point. These were found on both sides of the centre, but are attributed to some peculiarity of this particular tube. The effect of a change in the potential of the ring was studied, and it was found that below 550 volts there was practically no ionization. At this point, however, there was a sudden flow of current, and the effect then increased fairly regularly with increase in the potential of the ring. A small storage battery was connected in the galvanometer circuit, and it was found that only a few volts were needed to reverse the current when the coil was near the centre of the tube, and a large current in the opposite direction was readily produced. But to produce the same effect with a coil near the end of the tube, a considerably higher battery potential was necessary, in the neighborhood of 100 volts. It was also found that the maximum current produced by a given battery potential was secured when the battery was opposed to the ionizing current. An electrostatic voltmeter was then substituted for the galvanometer, the object being to avoid the flow of current and to measure the potential effects. The curves secured in this way were about the reverse of those given by the galvanometer, the potential being zero when the coil was at the centre of the tube and increasing rapidly as it was moved toward the ends to values too high to be measured. It was found that the electrostatic voltmeter took up its final position much more quickly when the ring was near the centre of the tube than near the ends. The small deflections due to the former position were reached in the fraction of a second, while for the large readings near the ends several minutes were necessary to charge the voltmeter to the indicated potential. This, again, seems to indicate a maximum current effect when the ring is near the centre of the tube. Any theory accounting for this phenomenon must explain the following features: (1) A direct current is caused by an alternating electrostatic field. (2) The positive pole of the tube is always the one nearest the exciting ring. (3) The maximum currents are obtained at points nearby, and on either side of, the centre. (4) The terminal voltage of the tube varies oppositely from the current; it is minimum when the current is maximum. The author then studies the effect from the theory of ionic conduction of current and the relative velocities of the ions due to the potential gradients set up between the ring and the electrodes. He deduces a number of equations for these effects, which are apparently in agreement with the results observed and seem to account for the effect of electrification. Further experiments are, however, in progress to study the effect of changes in the form of the tube, variation of frequency, pressure, etc.

REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE

Interference Preventer for Wireless Telegraphy.

A description is given here of the method developed by R. A. Fessenden for preventing interference with a receiving wireless telegraph station due to neighboring stations. This method is based upon the fact that resonance curves in general have a curvature of the same sign. Hence, if three circuits having a very small damping are carefully tuned, the one to the frequency which it is desired to receive, and the others to a higher and a lower frequency, respectively, the latter two circuits can be made to neutralize the effect of disturbing impulses—those not of the desired frequency—which are caught by the properly tuned aerial, and which would otherwise be heard in the receiving instrument. In practice but a single vertical antenna is employed, connected to three separately tuned circuits. Each circuit contains a detector, which is preferably a solid baretter, and the necessary cell and potentiometer arrangement. The receiving or, rather, indicating instrument is a telephone having four coils, two on each limb of the magnet. One of these coils is placed in each of the auxiliary circuits, the remaining two being placed in the one tuned to the exact frequency of the signals to be received. The latter coils are arranged so that their windings oppose the action of the other two coils, and they are made somewhat weaker than these coils, having fewer turns. When a disturbing impulse strikes all three antennæ this will, if not in tune, produce nearly equal effects in all the baretters, and hence these effects will neutralize each other as regards their effect upon the diaphragm of the telephone. If, however, the oscillations are of the proper frequency, the baretter in the antenna circuit of the proper frequency will be very much more strongly affected than either of the others, and thus the telephone will be actuated. This effect can be enhanced by making the damping of the two auxiliary antennæ somewhat greater than that of the other. The adjustment of the relative strengths of the coils is the most important point. This, it is said, may be done either by calculation or by trial. The arrangement, although simple, is effective. Professor Fessenden thinks that some such system is essential, as he does not believe that mere tuning to the wave-frequency, however carefully it be done, will insure against interruptions from disturbing sources.—*Abstracted from the Electrician (London), May 22.*

A Four-Year Course in Industrial Engineering.

The low efficiency of the craftsmen in various trades in America is, according to Professor Hugo Diemer, becoming a cause of concern not only to employers and owners of industries, but to the leaders of organized labor as well. The tendency toward specialization makes it well nigh impossible for apprentices to get a good general knowledge of their trade, such as was in former years quite possible. In striving for a variety of experience the young tradesman is forced to adopt a nomadic life, a process that few can follow advantageously. It is often said that tradesmen coming from Germany are better all-around workers in their craft than the average Americans in the same occupation, for which result the German "continuation" schools, or trade schools, are largely responsible. The author thinks that a similar system of vocational schools is needed in this country for preparing the young workmen to be better workers. Hand in hand with these secondary schools we need, further, a more advanced class of vocational schools for such students as have completed their general-culture high-school course at the age of eighteen and wish to spend about two years in becoming proficient in one of the more advanced trades, such as lithography and printing. The author then discusses some of the weaknesses of the present technical schools. The graduates of these schools usually are taken by large manufacturing concerns, as the immediate opportunities and surroundings are more attractive there, but he thinks that it is the smaller industries which would offer the greatest opportunity for such men, though as yet these industries have seldom availed themselves of the services of trained men. The most wasteful power plants, the most inefficient manufacturing processes, the most uneconomical building arrangements, and the poorest organization methods are found in the smaller industries. The opportunities offered here for the trained man to become a leading factor in the business are great, but to do this he must put up with the inconveniences and annoyances due to his surroundings during his first years. To make the most of these opportunities the young man should have had a special training, which he can not easily obtain from the present technical courses. The author then compares the mechanical engineering courses offered at twelve leading engineering schools and shows where the work there might be reduced to make room for other instruction which is not now given. He lays out a four-year curriculum in industrial engineering, the aim of which is to teach fundamental scientific and engineering principles without going too greatly into details and spending too much time on processes that change from year to year. The study of languages is considered important, and a good deal of time is given to the study of political economy, elements of accounting, commercial law, commercial geography, theory and history of money, banking, history of development of industrial society, industrial and social history of the United States, transportation, corporations, factory organization and administration, engineering specifications, heating and ventilating, and architecture.—*Abstracted from the Engineering Magazine (New York), June.*

The Merz-Price System of Automatic Protection for High-Tension Circuits.

A description is given here of the method of protecting electrical distributing systems devised by C. H. Merz and B. Price, which has been used in the north of England for some time with considerable success. The system is now installed on seventy feeder cables, covering a route of about 200 miles, working at 6,000, 12,000 and 20,000 volts, together with fifty substations having apparatus with an aggregate rating of 50,000 kilowatts. Since the system was installed it has been found that a shock due to a breakdown at any point is scarcely noticeable at the power station, and in no case has the synchronism of the machines been upset. The general principle of the system is that a balance is created under normal conditions

between the power which is flowing at the points of entry to and exit from the cable, or apparatus, to be protected, and means are taken whereby this balance is disturbed only when leakage takes place between the points of entry and exit, due to a breakdown. The simplest arrangement of this system for a three-phase transmission cable consists in running in the same duct a three-core, low-tension pilot cable. At each end the latter is connected to three-phase relays or to three single-phase relays, and to secondary windings of current transformers, the primaries of which are in series with the cores of the main feeder cable. These relays are of the simplest possible character and act only as contact makers. They close a local battery circuit for a moment only, and at the same time release a falling weight, which in turn short-circuits the contacts just made. Since the current at both ends of the main cable, neglecting the inappreciable capacity current, must be the same at every instant, it is evident that unless there is leakage between the two sets of current transformers, the inductive effect which this current will produce in the pilot-wire circuits will be equal and opposite, so that no appreciable current will flow through the relays; but as soon as there is leakage the balance will be upset and a current capable of operating the relays will flow. The system fulfils the following conditions: It discriminates with certainty—that is to say, it is certain of action on faulty cables, but inoperative with equal certainty on healthy sections. It is suitable for use on all possible arrangements of cables, whether these be separate, or interconnected, or forming parts of complicated networks. It is instantaneous in isolating a faulty piece of apparatus, and it entails only the simplest possible apparatus. With the ordinary systems of protection, when a fault occurs at some distance from the power station, the heavy rush of current has to flow through several overload relays in series, and it is difficult to prevent these from operating almost simultaneously and isolating undamaged sections of the system. This effect is avoided in the system just described because it depends upon the combined effect of the current at both ends of the cable, and when these are equal the relay is not affected. The controlling system is thus independent of the magnitude of the operating current, of the voltage of the supply and of the direction of flow of power in any of the phases. The system may be arranged especially with a view to avoiding time-lag, and since, in most cases, currents at both ends of the cable combine to operate the relay on the overloaded section, the apparatus is rendered doubly sensitive and rapid in action. The balancing of these three-phase relays may be obtained by opposing electromotive forces or by a form of magnetic balancer in which magnetomotive forces are opposed to one another. The first method is most readily applicable to the protection of feeder cables, while magnetic balancing is best suited for the protection of transformers and other apparatus in the station. When magnetic balancing is employed, it is possible to combine the protective gear with the measuring apparatus by using the same current transformers.—*Abstracted from Electrical Engineering (London), May 21.*

Inductive Interference with Telephone Circuits in Proximity to High-Potential Transmission Lines.

The author of this study has had considerable experience in the operation of telephone circuits in proximity to high-tension lines on the Pacific coast, and he here gives the results of his experience. He first discusses the theory of interference and methods of compensating for this by distribution. Theoretically, transposition should be effective if carried out once at the centre of the disturbing section, but this is impracticable because, although the resulting effect at the extreme ends of the circuit might be zero, the strains thrown upon the telephone system would be destructive. It is necessary to transpose the power circuit as well as the telephone. Transposition of the power wires is effective only under conditions of perfect balance, and if the three phases vary appreciably such a transposition scheme is useless. The same is true should any one of the phases become grounded. The author has observed that the disturbance is more pronounced and somewhat different in character where the exposure is to a three-phase circuit operated with a Y connection and a grounded neutral, than with a Y connection ungrounded or with a delta connection. The effect in the former case seems to be due to the triple harmonics flowing back through the ground. Some details are then given of experiences through which he has passed, one occasion being the running of a 15,000-volt transmission system parallel to a telephone line at a separation varying from ten to sixty feet for a distance of approximately twelve miles. The total length of telephone line was in the neighborhood of seventy miles and the exposures occurred at rather widely separated sections. Until the grounded neutral was used on the transmission system the inductive effect was unnoticed, but as soon as a plant operating with a grounded neutral was connected in multiple with this system, the disturbance was such as to render the lines uncommercial. The high pitch of the disturbance was very noticeable in this case. The difference of potential from telephone line to earth, due to such disturbances, varies greatly and may be about eighty, or it may be over 700 volts. In one case where the line was particularly exposed a sixteen-candle-power, 110-volt lamp was connected between the wire and the ground. It glowed slightly. Connecting an alternating-current voltmeter in this circuit, it was estimated that the potential existing was about 610 volts. The current which had passed through the lamp was estimated at about two-tenths of an ampere. A condenser and ballistic galvanometer were then obtained and a maximum potential of 730 volts was found. An important question is: With a given length of exposure what separation must be considered essential? Although apparently simple, no reasonably definite reply can be given. Too much depends on the conditions of the telephone line throughout its entire length, the relative amount of open wire and cable, the kind of cable, the terminal apparatus, etc., all of which have an effect upon the result. Particular emphasis is laid upon the fact that while toll lines may be widely distributed, they are generally brought together along some route, and a disturbance originating on some isolated section of one line may affect a whole lead when it is brought to the main pole-line. Another effect is the impossibility of utilizing a phantom-circuit arrangement where there is any disturbance due to a transmission line. The conclusions drawn from this consideration are that the telephone lines should be separated as widely as possible from all sources of foreign electrical interference and particularly from high-tension transmission circuits, but practically it is impossible to prevent some exposure somewhere on the system. Wherever interference is found, separation should be made as great as possible, since the effect varies approximately as the inverse square of the separation.—*Abstracted from the Journal of Electricity, Power and Gas (San Francisco), May 23.*

INDUSTRIAL SECTION

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS

The Willis "Straight-Line" Meter.

One of the features of the exhibition of the Federal Electric Company, Lake and Desplaines streets, Chicago, Ill., at the recent convention of the National Electric Light Association at Chicago, which attracted a great deal of attention from central station men, and which the company announces has jumped into immediate popularity, was the Willis "Straight-Line" meter. This meter can be read as easily by the customer as by the central station man, as there is no constant used and it reads directly in kilowatt-hours. It may be used on either direct or alternating-current circuits without readjustment, and is stated to be equally accurate on inductive and non-inductive loads. Its current consumption on potential in all 110-volt sizes averages two watts. The instrument is built without jewels, and eliminates the possibility of disablement through cracking or roughening.

The meter is not affected by light vibrations of walls or partitions, nor is it thrown out of adjustment easily by rough handling. It leaves the laboratory hermetically sealed, and is air, water, dirt and gas-proof.

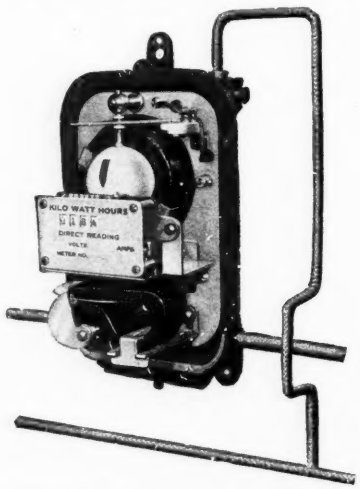
It can not be successfully tampered with without detection and can not run backward. Any outside magnetic influence placed around the meter will tend to run it fast. It has a magnetic shunt, by means of which the speed of the meter may be altered, avoiding the necessity of shifting the magnet.

The meter has a zero temperature coefficient, giving the same reading in extremes of heat and cold. The commutator and brushes are made from a non-arcing, non-corroding alloy. There are three bars in the commutator, making the bars wide and the air-gaps narrow.

The brush-holders are mounted on a porcelain base, insuring rigid and permanent position. The potential resistance is a fireproof spool made of porcelain, with porcelain-enameled wire. The connecting terminals and sealing devices are conveniently placed.

The cyclometer integrating index has instantaneous action number wheels, and the instrument has a high torque factor compared with the weight of its moving parts.

The entire works can be removed in one piece, leaving the field coil and resistance in position in the base, and the works can



INTERIOR VIEW, WILLIS "STRAIGHT-LINE" METER.

be replaced in the meter and the meter will then read the same as before without readjustment. The case or cover can be removed by removing one screw.

EXTERIOR VIEW, WILLIS "STRAIGHT-LINE" METER.

The armature is enclosed in a watertight hollow ball, so that the coils can not be injured by rough handling. The ball does not become displaced in shipment and is always ready to rotate.

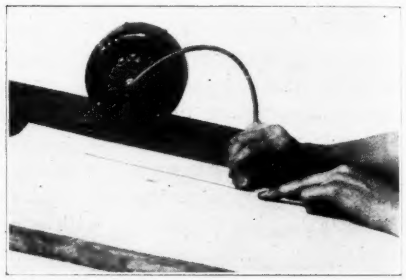
The integrating index does not take more power to operate four number wheels than the first wheel alone. It has a glass-hard ball bearing with iridium steel cups. The ball bearing can be removed without the use of tools in a moment.

The 600-watt size starts on two watts, and all sizes are tested on twenty per cent overload, at which the field coils are cold.

The instrument is an iron-clad meter and weighs six and one-quarter pounds for all sizes.

Motor-Driven Eraser.

In even the most careful work in engineering offices and drafting rooms mistakes will occasionally be made and changes are frequently necessary, requiring alterations in tracings. It is well known by draftsmen that erasing with a



MOTOR-DRIVEN ERASER.

very light, fast motion will remove the lines without a scar. But most draftsmen do not have the patience to do the work without putting too great a pressure on the rubber, and the result is a marred tracing. The use of a scratcher leaves the poorest job of all. For these reasons an eraser driven by a small electric motor finds great favor among draftsmen.

The eraser shown in the illustration is connected to the small Westinghouse motor by a Coates flexible shaft, allowing the motor to remain in one position near the edge of the table from which any spot in the drawing may be reached. If desired, the motor may be carried from table to table, as its weight is but little. In some cases a separate bench is used for erasing, and all tracings, etc., requiring correction are brought there.

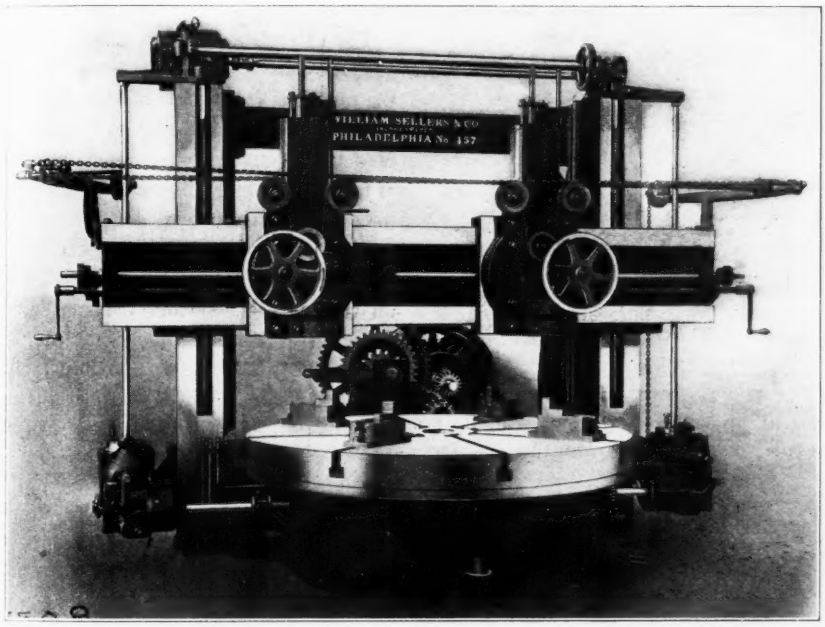
Th motor is supplied for either direct or alternating current, one-twelfth or one-

eighth horse-power. The high speed of the motor gives the circular eraser the required high speed, so that but a light pressure is required to remove any lines desired. The tendency of men unfamiliar with the use of these erasers is to put too heavy a pressure on the eraser. This results in overheating the paper and in some cases may injure it enough to spoil the drawing. But with a little practice any one may readily learn to use the eraser very rapidly and accurately.

The complete outfit is supplied by the Coates Clipper Manufacturing Company, of Worcester, Mass.

Boring and Turning Mill.

Manufacturers in America make more extensive use of boring and turning mills than the manufacturers of any other country, although this useful machine tool



MOTOR BACK-GEARED TO MILLING MACHINE.

was first developed in England. This is due to the improvements made by American machine-tool builders who materially improved upon the types manufactured by their foreign competitors.

The range of use to which this machine may be put is very wide. In many shops it takes the place of a lathe because for many classes of work it is the more economical tool, owing to the facility with which the work can be set on the face-plate. In some shops it is customary to place a number of pieces of comparatively small work on the surface of the table around the edge and thus turn almost a continuous ring. When the work permits it, both tools on the cross-head may be made to cut at the same time, one on the top of the work and the other on the side.

In order to provide for the greatest output for a tool of this nature, it is necessary to provide the greatest convenience for all the movements, horizontally, vertically, engagement and disengagement of feeds, etc., so that the machine can be kept under cut as much of the time as possible. The time which is lost in preparing work reduces the output of the machine, and it is the output that brings profit. The actual investment charge for the machine will in many cases be found to be a more important item than the labor charge and hence every increase in production is a direct saving.

By using a variable-speed motor installed as an integral part of the boring mill, the correct speed may be obtained in the minimum amount of time, as the controller handle is conveniently located for the operator.

The boring mill shown in the illustration, built by William Sellers & Company, Incorporated, of Philadelphia, is capable of taking work eighty-four inches in diameter. The variable-speed motor, supplied by the Westinghouse Electric and Manufacturing Company, has a speed range of two and one-half to one, giving the table any speed between one and 23.8 revolutions per minute with the exception of two small gaps. The feed may be varied from one-thirty-second inch to three-quarters inch per revolution of the table in eight steps.

The machine is entirely self-contained and not dependent upon supplemental foundations for its rigidity, as the only portion of the machine extending below the floor line is the lever for adjusting the centre step, which is accommodated by a trough seven inches wide by seven inches deep. The table has a flat bearing with a central spindle and adjustable step controlled by the lever mentioned above.

The use of the motor permits the machine to be located where the work can be supplied to it with the least handling, thus decreasing the lost time, when the machine is not producing.

New Adapter for Tungsten Lamps.

The Benjamin Electric Manufacturing Company, Chicago, Ill., is placing on the market a new device in the form of an

FIG. 1.—BENJAMIN ADAPTER.

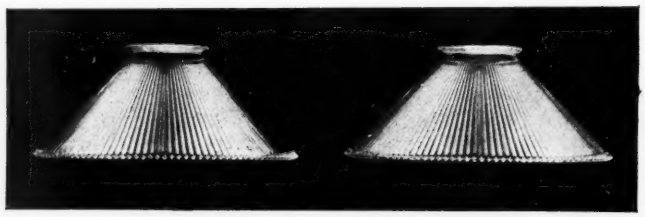
adjustable plug socket, the principal use of which is that of an adapter for tungsten lamps. It is provided with rotating sleeve which permits a complete revolution

FIG. 2.—BENJAMIN ADAPTER.

of the socket, together with a hinge joint securing almost any angle of adjustment desired. The position of lamps in a fixture or bracket may thus be changed to the vertical. This is shown in Fig. 1. Where lamps are desired at right angles—*i. e.*, with a horizontal socket or receptacle—a second device is furnished. This is illustrated in Fig. 2.

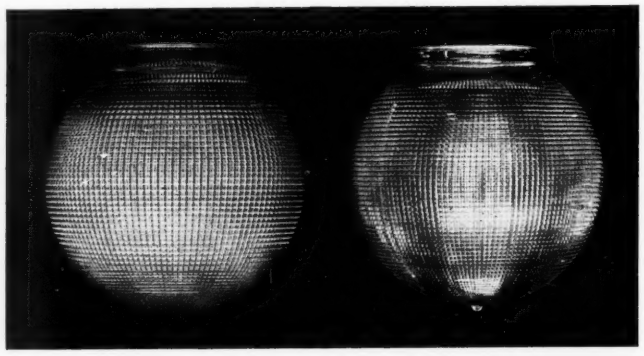
Holophane and Imitation Glassware—An Interesting Comparison.

That the unsupported claims of manufacturers can not always be accepted at their face value is shown by some remarkable tests recently completed by the Electrical Testing Laboratories, of New York city. The tests were made to determine the relative values of various prismatic reflectors and proved conclusively that it is practically impossible to judge as to the efficiency of such reflectors by merely comparing their outward appearance.



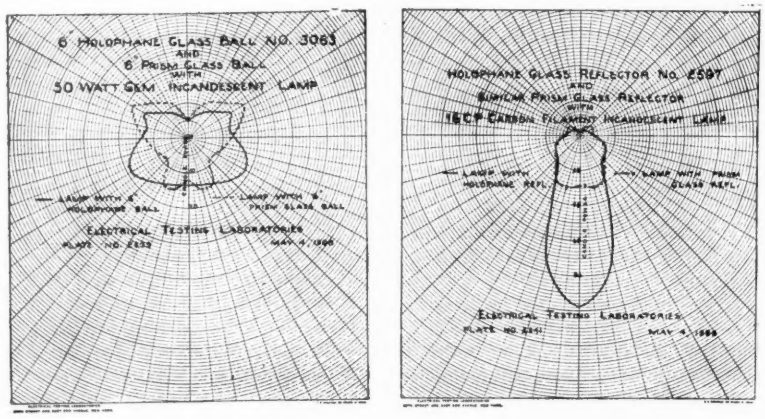
HOLOPHANE REFLECTOR NO. 2507 ON THE LEFT, AND IMITATION.

The accompanying illustrations demonstrate this very clearly in the case of two Holophane reflectors and two superficially exact imitations. In the photographs this telltale similarity is seen, especially in the case of reflector No. 2507. The photometric comparison, however, is evidence of the inefficiency of these imitations from the standpoint of illumination, and that the entire attention of this imitator was devoted to counterfeiting the Holophane product in appearance.



SIX-INCH HOLOPHANE NO. 3063, ON THE LEFT, AND "NEAR HOLOPHANE" BALL.

The manufacturer of scientific reflectors will probably always suffer from the inroads of imitators, owing to the fact that his product is of necessity high-priced as compared with unscientific "prism glass," which is so similar that fraud is practically imperceptible to the eye.



DISTRIBUTION CURVES OF HOLOPHANE AND IMITATION REFLECTORS.

It is, of course, but natural that there should be a ready market for cheap glassware among those to whom the matter of price is the determining factor. Also, it is easily understood why unscientific reflectors can be sold at a price far below that of the reflector of proved efficiency.

The scientific reflector is the product of engineering skill and experience in designing; special high-priced mold-making machinery is required; special glass of intense brilliancy and cleanness must be used in order to maintain a low absorption factor; and the workmanship must be of the very highest class.

Neither price nor outward appearance can be taken as proof of efficiency, and nothing should be accepted as "just as good" without a photometric comparison.

The Purchase of the Lafayette Electrical Manufacturing Company.

The Duncan Electric Manufacturing Company, Lafayette, Ind., has purchased the machinery, tools, etc., of the Lafayette Electrical Manufacturing Company, and is actively engaged in the manufacture of high-grade, high-efficiency transformers. The company has secured the services of one of the most competent transformer engineers in the country, and will place on the market none but transformers of the highest possible grade. The company is availing itself of every modern facility for this particular line of apparatus and is prepared to furnish transformers of any size to conform to any specification. Heretofore the Duncan Electric Manufacturing Company has been well known as the maker of first-class integrating wattmeters. In taking over the new line, Thomas Duncan, managing director of the company, states that it is the company's purpose to see that the new product is always of the highest order.

Brilliant Electric Lamps—A Correction.

The Brilliant Electric Company, Cleveland, Ohio, manufacturer of Brilliant tungsten, tantalum and standard carbon-filament incandescent lamps, also standard carbon-filament tip or tipless incandescent lamps, was the victim of a typographical error in a recent advertisement in the ELECTRICAL REVIEW, whereby the phrase, "tip or tipless," was made to read "ty or tylers."

THE GREATEST ROOF SIGN IN THE WORLD.

BY BENJAMIN WALL.

In the issue of the ELECTRICAL REVIEW for September 27, 1907, the writer referred to the roof sign Colgate & Company intended placing on their Jersey City (N. J.) factory. The photograph shown on this page is a night view of the new sign built by the Metropolitan Engineering Company and can easily be read in Brooklyn and lower Manhattan.

THE BIG COLGATE SIGN. TWO HUNDRED FEET WIDE BY FIFTY FEET HIGH. THE CLOCK IS THIRTY-EIGHT FEET HIGH.

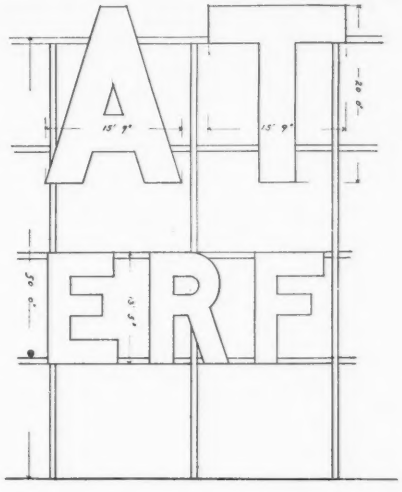
While there are many notable roof signs on the river front, the Colgate sign undoubtedly excels in size, being over twice as large as any other. Some idea of the size of this sign may be gathered from the following data:

The framework is 200 feet wide by fifty feet high, thus giving a total area of 10,000 square feet available for display purposes. The total weight of the framework exceeds seventy-five tons, the material used being eight-inch channel iron throughout, and to quote the consulting engineer of the Colgate Company, "is of sufficient strength to withstand any amount of wind pressure, even were the sign one solid sheet such as is used for billboard display."

The framework is anchored to the building by rods which run through the roof beams and down to the beams of the floor below the roof; the letters in "COLGATE'S" are twenty feet high, with receptacles for lamps placed six inches apart; the letters reading "SOAPS, PERFUMES" are thirteen feet five inches tall, and are of the grooved-skeleton type of construction. To build the letters it required over two tons of No. 22 gauge galvanized iron, and for reinforcing the edges of the letters about one ton of steel rod was necessary.

Some 30,000 feet of No. 14 double-braid rubber-covered wire was used in wiring the sign and making connection to the service on the roof, all of which was executed in accordance with the rules of the New York Board of Fire Underwriters.

The clock shown in the photograph is a feature which should not be overlooked when contemplating the hugeness of this proposition. Not only is the sign the largest in the world, but the clock is in the same class, the diameter being thirty-eight feet. The clock weighs approximately six tons, of which the weight that moves the hands is 2,000 pounds. The minute hand weighs nearly one-third of a ton.



DETAIL OF LETTERS ON COLGATE ROOF.

Some idea of the immense size of this clock may be gained from the fact that twenty men placed shoulder to shoulder could stand across its face.

To Exploit German Arc Lamps.

Fox Brothers & Company, 126 Lafayette street, New York city, have recently established an electrical department in connection with their railway supply business, to market in this country the modern line of arc lamps made by the Carbone Licht Gesellschaft, of Germany. This line includes the "Polar" flaming arcs for both direct and alternating currents. These lamps are reliable and embody the latest practice. Many thousands are burning in all parts of the world. The "Carbone," one of the latest developments in arc-lamp construction, gives a pure white light and is suitable for both inside and outside use. The "Radiante" lamp for direct current is particularly adaptable to stores, offices and the textile and printing industries. Its soft white light is very pleasing and the lamp is highly efficient in operation. The "Radiante Economy" lamp covers the same field, but gives less light on a lower current consumption. The "Phalanx" lamp for alternating current has the same characteristics as the "Radiante" lamp. This line of lamps covers the entire arc-lighting field, and by means of suitable globes and reflectors the proper degree of illumination at the highest efficiency is obtained.

This department is in charge of D. D. Miller and L. J. Auerbacher. Mr. Miller has been for many years in the sales department of the Westinghouse Electric and Manufacturing Company, and will act as sales manager. Mr. Auerbacher has been identified with the technical and practical sides of the flaming-arc industry since its introduction in this country. He has studied this line in the lamp and carbon factories of Europe. On his recent trip abroad he secured the agency of the Carbone Licht Gesellschaft, which agency will form the nucleus of a wide line of electrical specialties which Fox Brothers & Company will handle in the near future.

United States Civil Service Examination.

The United States Civil Service Commission announces an examination on July 1 to secure eligibles from which to make certification to fill a vacancy in the position of assistant engineer, at $1,400 per annum, in the office of the Secretary of Agriculture, and vacancies requiring similar qualifications as they may occur. The age limit is twenty years or over on the date of the examination, and the examination is open to all citizens of the United States who comply with the requirements. Applicants should at once apply to the United States Civil Service Commission, Washington, D. C., for application form 1,093.

Current Electrical News

DOMESTIC AND EXPORT.

MONTEREY LIGHT AND POWER SYSTEM CHANGES HANDS—It is announced that the Monterey Electric Power and Light Company has sold its plant in Monterey, Mexico, to the Monterey Railway, Light and Power Company.

ELECTRIC LINE RECORDS $2,500,000 MORTGAGE—Mortgages have been recorded in Oakland, Cal., whereby the San Francisco, Oakland & San José Consolidated Railroad, recently incorporated, places certain of its right of way, rolling stock and real property in trust to secure a bond issue of $2,500,000 recently ordered by the directors. The railway company was incorporated for the purpose of building an electric line to San José along the eastern side of the bay. F. M. Smith and a number of capitalists are interested in the project.

TO BUILD NEW TROLLEY LINE—It is reported that representatives of Stern & Silverman, of Philadelphia, Pa., are working up a syndicate to finance the construction and equipment of a proposed new trolley line from Huntsville, Ala., to Nashville, Tenn., at a cost of about $2,000,000, securities to the amount of $1,000,000 of bonds with a like amount of stock to be underwritten and issued. It is claimed that all needed franchises for the line have been obtained and the road already capitalized at $150,000 in Alabama as far as the Tennessee line.

A TWENTY-FIVE-MILLION-DOLLAR POWER PLANT PLANNED—Colonel F. H. Ray, director of the American Tobacco Company and chief backer of the Great Western Power Company, and H. P. Wilson, of the firm of Brown & Wilson, financial agents, recently made a tour of inspection of the Great Western Power Company's property and the chief power-house of the company, located on the north fork of the American River, California. This plant is nearly completed and will commence to furnish power in the northern part of the state in October. It cost about $12,000,000 and is the largest on the coast. Colonel Ray says all the power that can be furnished by this plant already has been contracted for and announces that it has been decided that the power-house on the American River shall be enlarged to such a size that it will be capable of furnishing power throughout the state. This new investment will cost $25,000,000 and will be all subscribed by Eastern capital.

COMPANIES FORMED TO CARRY OUT POWER PLAN—The directors of the Kansas-Colorado Power and Railway Company met at La Junta, Col., on May 27, and formed two companies, the first to be known as the Kansas-Colorado Electric Transmission Company with a capital stock of $3,500,000, and the second, the Kansas-Colorado Railway Company with a capital of $5,000,000. The companies are formed for the purpose of putting into operation the plans of A. B. Hulit, of Madison, Wis., for the electrification of the Arkansas Valley from Cañon City, Col., to Dodge City and Scott City, Kan. Work will be commenced at once. The officers elected, identical for the two companies, were: S. H. Atwater, Cañon City, president; J. A. Lockhart. Rocky Ford, vice-president; Robert W. Patterson, La Junta, second vice-president; A. H. Warner, Garden City, secretary, and Andrew Russell, Dodge City, Kan., treasurer. The board of directors consists of Atwater, Lockhart, Patterson and Alva Adams and Andrew McClelland, Pueblo; J. Q. MacDonald, Florence; J. N. Baty, Manzanola; Samuel McIntyre, Las Animas; W. A. Gould, Lamar; William Humphreys, Syracuse, Kan.; J. W. Warner, Garden City; W. O. Bournier, Scott City, and Andrew Russell, Dodge City.

LARGE POWER PLANT TO BE BUILT ON WALLA WALLA RIVER—Announcement has been made that rights of way for a power-house, flume and water privileges on the south fork of the Walla Walla River, Wash., several miles above the present power plant of the Northwestern Gas and Electric Company, have been secured by the trustees of the Washington & Oregon Traction Company, a syndicate of local capitalists, which intends to build a 5,000-horse-power plant in the near future. The company has been organized for some time. The promoters of the new power plant intend to furnish power to operate the future electric lines of the Walla Walla Valley and surrounding territory. Rights of way have already been secured by the company for a roadbed to the summit of the Blue Mountains, about 330 miles distant from Walla Walla. The line will probably be extended to the Wallowa Valley on the one side of the Walla Walla, and to the Columbia River on the other, thus placing eastern Washington and Oregon in direct communication with tidewater. The new enterprise is being financed entirely by Washington capitalists, and is under the direction and management of a board of trustees composed of E. S. Isaacs, Max Baumeister, C. K. Holloway, Allan H. Reynolds, Samuel Drumheiller, John Smith, W. A. Ritz and John L. Sharpstein, of Walla Walla.

NEW INCORPORATIONS.

MACON, GA.—Citizens' Electric Company, $100,000.

TRENTON, N. J.—Patapsco Electric Company, Bayonne. $500,000. Incorporators: C. S. Noe, F. C. Earl, Bayonne.

GUTHRIE, OKLA.—Walker Telephone Company, of Texola. $10,000. Directors: J. E. Walker, R. Blossom, V. B. Walker, all of Texola.

COLUMBUS, OHIO—Nelsonville & Murray Home Telephone Company, Nelsonville. $50,000. Incorporators: Elmer O. Pettit and others.

TOPEKA, KAN.—Citizens' Mutual Telephone Company, Bavaria: $10,000. O. B. Walker Telephone Company, Howard; capital increased to $20,000.

GUTHRIE, OKLA.—Chateau Telephone Company, of Chateau. $1,500. Directors: W. A. Crockett, M. E. Adkins, W. E. Grany and A. F. Fennigh, all of Chateau.

NASHVILLE, TENN.—Home Telephone Company, of Trousdale County. $1,000. Incorporators: J. H. Rickman, P. E. Burnly, J. B. Johnson, E. M. Haynie, Albert Wakefield and J. E. Faust.

ROCHESTER, N. Y.—Benton Telephone Company. $1,000. Directors: Edward Hurrin, Walter Lebbon, Glenn L. Turner, I. W. Comstock, Walter E. Beattie, J. K. Turner, all of Middlesex.

MONTGOMERY, ALA.—Alabama Railway and Electric Company. To build a line of road from a point near Anniston, in Calhoun County, to a point near Dothan, in Houston County. $200,000.

INDIANAPOLIS, IND.—Indianapolis, Cloverdale & Terre Haute Traction Company. $10,000. Directors: E. W. Bowman, H. F. Butze, S. P. Axtell, William L. Cooke and Harry C. Sandresky.

JACKSON, MICH.—The South Bunkerhill & North Henrietta Telephone Company. $1,000. Stockholders: Mrs. Alice Call, Bert D. Grow, J. L. Artz, Orville Gee, Carrie M. Titus, C. Knauf, William Leece, J. S. Leece and others.

TRENTON, N. J.—Billings & Eastern Montana Power Company, Newark. To operate by electricity or other power street and interurban railways, etc. $1,000,000. Incorporators: P. E. Bisland, Bronxville, N. Y.; C. R. Ganter, New York city; R. Randell, Brooklyn, N. Y.

GUTHRIE, OKLA.—The Guthrie & Interurban Railway Company, of Guthrie. $100,000. To build a line from Guthrie to a point on the Cimarron River, five miles, at an estimated cost of $20,000 per mile. Incorporators: C. R. Renfro, F. E. Houghton, G. Crow and R. E. Overton, of Guthrie, and E. C. Brown, of St. Louis.

PERSONAL MENTION.

MR. L. A. VOIGHT has been made superintendent of the municipal electric light plant at Seguin, Tex.

MR. H. H. PATTERSON, of Philadelphia, Pa., has been appointed superintendent of the Easton Transit Company, of Easton, Pa.

MR. CHARLES L. SHELDON, chief engineer of the Norwich & Westerly Railway, Norwich, Ct., has resigned, being succeeded by Joseph Rowley, of New London, formerly engineer for the New London Gas and Electric Company.

MR. W. R. GOUDY, secretary of the Syracuse (N. Y.) Lighting Company, has been transferred to Philadelphia, Pa., where the head office of the United Gas Improvement Company, which now controls the Syracuse Lighting Company, is located. W. R. Elliott, of Philadelphia, assumes Mr. Goudy's duties at Syracuse.

MR. R. L. BRITAIN has resigned as superintendent of the village electric light plant at Northfield, Vt., to accept the position of superintendent of the Moody & Almon Company, of Montpelier. The resignation is effective July 1. Mr. Britain has been at Northfield two years. He was five years manager of the Richmond Light and Power Company, and has also been connected with the Consolidated Lighting Company.

MR. MILTON HARTMAN, well known in incandescent lamp circles, has taken the sales management of the tungsten lamp fixture department of the Brilliant Electric Company, Cleveland, Ohio. This is a new department being organized by the Brilliant Electric Company to push the new tungsten unit, consisting of an artistic nickel-plated fixture equipped with Holophane reflectors and Brilliant tungsten lamps.

MR. FRANCIS M. HARTMANN, who has succeeded the late Professor William A. Anthony in charge of the department of physics and electrical engineering at Cooper Union, New York city, was born at Cochecton, N. Y., on August 30, 1870. He was graduated with the degree of bachelor of science in 1895 from the general science course of the night school of Cooper Union. Three years later he was graduated from the course in chemistry. He took the post-graduate degree of electrical engineer in 1903, and also finished the advanced work in mathematics at the New York University that year. He was a city surveyor from 1891 to 1894, and computer for the Department of Public Improvements, New York city, from 1894 to 1901. He was instructor of physics and electrical measurements at the Cooper Union night school from 1898 to 1901, instructor of physics and electrical engineering of the Cooper Union day and night schools, 1901-1905; assistant professor physics and electrical and mechanical engineering, 1905 to December, 1907. Since December, 1907, he has been professor of physics and applied electricity. On May 5 last Professor Anthony resigned from active teaching, and requested that he be made professor emeritus. In his letter of resignation to the trustees of Cooper Union Professor Anthony said: "As to the continuation of the work in the department, I would suggest that Professor Francis M. Hartmann be given full charge for both day and night schools. . . . He has been connected with the department as a student or instructor from the beginning of my connection with the institution. He has been teaching in the department for ten years or more. He grew up with the department and knows all about its workings and the instruction given. No man has or could have a more complete knowledge of all the details of the work than has Professor Hartmann. He developed the electrical course in the night school, and has had much to do with the development of the mechanical and electrical engineering courses in the day school. He will be ably assisted by Professor Ball, who has been connected with the department for three years. Professor Ball graduated from Cornell University and had some years' experience in teaching before he came to us." Professor Hartmann has done a good deal of expert work, devoting his attention particularly to a study of iron losses and to research in alternating-current phenomena. While his time has necessarily been limited by his active work at Cooper Union, he has accomplished a great deal in these lines. It is particularly fortunate that the great work which Professor Anthony inaugurated and developed at Cooper Union should be left in such capable hands. Not only is Professor Hartmann a thorough instructor, but he has a keen understanding and appreciation of the difficulties under which the students in such an institution labor.

F. M. HARTMANN.

ELECTRICAL SECURITIES.

An early quieting down was evident in last week's stock markets, and this is in line with current expectations. Price movements were decidedly irregular, and while there were not many decided tendencies the leading industrials made slight net gains over the closing prices of the week previous. There seems to have been an almost total absence of support from outside speculators, and the market consequently was more obviously worked by professional manipulators. The government crop reports and the presidential election are now looming large as factors, but notwithstanding a natural apprehension concerning these important issues there appears to be a genuine improvement in business and a more hopeful feeling for the immediate future in all phases of industry.

Dividends have been declared by the following electrical companies: Chicago Telephone Company; regular quarterly dividend of 2½ per cent, payable June 30. Books close June 25, and reopen July 1. Canadian Westinghouse Company, Limited; regular quarterly dividend of 1½ per cent on its capital stock, payable July 10 to stockholders of record June 3. United Traction and Electric Company; regular quarterly dividend of 1¼ per cent, payable July 1. Books close June 9 and reopen July 2. Interborough Rapid Transit Company; regular quarterly dividend of 2¼ per cent on the capital stock, payable July 1 to holders of stock and voting trust certificates of record on June 15. Books close June 15 and reopen July 1.

ELECTRICAL SECURITIES FOR THE WEEK ENDED JUNE 6.

New York:	*Closing.*
Allis-Chalmers common	9
Allis-Chalmers preferred	26⅜
Brooklyn Rapid Transit	49
Consolidated Gas (ex dividend)	123½
General Electric	134
Interborough-Metropolitan common	11¾
Interborough-Metropolitan preferred	32⅜
Kings County Electric	112
Mackay Companies (Postal Telegraph and Cables) common	65½
Mackay Companies (Postal Telegraph and Cables) preferred	65¼
Manhattan Elevated	136¾
Metropolitan Street Railway	23
New York & New Jersey Telephone	100
Western Union	54
Westinghouse Manufacturing Company	49

Boston:	*Closing.*
American Telephone and Telegraph	118
Edison Electric Illuminating	—
Massachusetts Electric	45
New England Telephone	110
Western Telephone and Telegraph preferred	—

Philadelphia:	*Closing.*
Electric Company of America	9⅞
Electric Storage Battery common	31½
Electric Storage Battery preferred	31½
Philadelphia Electric	9½
Philadelphia Rapid Transit	13⅜
United Gas Improvement	84¼

Chicago:	*Closing.*
Chicago Telephone	126
Commonwealth Edison	94¾
Metropolitan Elevated preferred	50
National Carbon common	65½
National Carbon preferred	110

The daily passenger traffic average for May on the Metropolitan Elevated was 145,117. The daily average traffic for May on the Northwestern Elevated was 105,001, an increase of 10,797. The Chicago & Oak Park Elevated average traffic was 45,948, a decrease of 2,735.

ELECTRIC LIGHTING.

ALMA, KAN.—A contract for lighting the city has been let to the Alma Light and Power Company.

CARROLLTON, KY.—The city council has let the contract for a new electric light plant to Sam Hill, Jr., of Cincinnati, for $19,200.

BAIRD, CAL.—William Ellery, of Reading, has filed on 124,000 inches of water in the McCloud River, near this place, for the purpose of generating electrical power.

FREMONT, NEB.—The board of public works has awarded the contract for the switchboard for the new electric light plant to the Fort Wayne Electric Works, of Fort Wayne, Ind.

RICHMOND, VA.—The council has passed an ordinance providing for the issuance of $350,000 four per cent thirty-four-year bonds for the building of an electric light plant.

EAU CLAIRE, WIS.—The city council has let a lighting contract to the Chippewa Valley Railway, Light and Power Company for three years for 140 arc lights at $56.40 each per year.

TAYLOR, TEX.—A contract for a $5,000 brick building has been awarded by the Citizens' Light and Power Company. New machinery to the value of $40,000 will be installed in the new building by September 1.

ARMADA, MICH.—This village is to be electrically lighted, the council having entered into a contract with the St. Clair Edison Company under the terms of which a lighting system will be ready for operation by next November.

GRIDLEY, CAL.—The plans of Ralph Beebee, engineer, for the installation of water and light systems have been adopted by the board of city trustees. The water plant, which is to cost $30,000, will furnish current for the lighting plant, estimated to cost $3,000.

OGDENSBURG, N. Y.—Edward L. Thornton, of Chicago, has purchased the electric light plant at Heuvelton, formerly operated by S. J. Delaney and Jay Francis. Mr. Thornton will incorporate the business under the name of the Heuvelton Heat, Light and Power Company.

ROCHESTER, N. Y.—Joseph E. Putnam, who has been looking into the matter of installing electric plants in the court house and armory, recommends to the county building commissioner the installation of a $5,000 plant at the court house and a $4,000 plant at the armory.

BILLINGS, MONT.—The Madison River Power Company has purchased the Yegen Brothers' electric light plant in this city. The consideration is not made public. The plant furnishes light to many business houses and residences in Billings, as well as current for street lighting.

JOLIET, ILL.—Colonel I. C. Copley, of Aurora, president of the Western United Gas and Electric Company, has accepted a franchise granting his company the use of the public streets for fifty years. With the filing of the acceptance he deposited $6,000 and will pay an additional $10,000 within sixty days.

EVANSVILLE, IND.—A company has been formed at Poseyville, Ind., to operate an electric light and heating plant. The work of installation will be started immediately. Tungsten lamps are to be used. A. L. Swanson, an Evansville electrical contractor, has the contract for furnishing and installing the entire equipment.

NOBLESVILLE, IND.—Acting on the application of Asa C. Haynes, of Peru, Judge Christian has appointed Gus P. Wing and A. E. Shaffer receivers for the Arcadia Electric Light Company, which is supplying residents of Arcadia with electricity for heat and light purposes. The plant is owned by John A. Shunk, of Peru.

MOUNT CARMEL, PA.—The Edison Illuminating Company, of Mount Carmel, has signed contracts for the purchase of sufficient machinery to increase the capacity of the plant one hundred per cent. The contracts call for an expenditure of between $20,000 and $30,000, and the machinery is to be delivered within the next four months.

EUREKA SPRINGS, ARK.—At a meeting of the Citizens' Electric Company George Tilles, of Fort Smith, and Lovick P. Miles resigned as directors and a new board of directors was chosen, as follows: W. M. Duncan, Dr. J. D. Jordan, C. C. McCarty and C. F. Ellis. Dr. J. D. Jordan was elected president of the board, M. D. Jordan, vice-president, and C. C. McCarty, secretary and treasurer.

GREEN BAY, WIS.—The Hydro-Electric Company has been organized at Green Bay with a capital stock of $1,000,000. J. H. Josslyn, of Oshkosh, was chosen president, A. M. Murphy vice-president, E. P. Papler secretary and Frank Murphy treasurer. The last three officers are from Green Bay. The company will locate at Peshtigo and will furnish power to the Green Bay Traction Company, Green Bay Electric Company and other firms.

AKRON, OHIO—To harness the water power of the Cuyahoga River at Cuyahoga Falls, aggregating a fall of over 100 feet, is said to be the project of the Cuyahoga Light, Heat and Power Company, incorporated in Cleveland. Notices have been served on land owners along the river announcing the beginning of condemnation proceedings to get possession of the river bed for miles under a special statute passed two years ago, permitting water power corporations to appropriate land.

EVANSVILLE, IND.—Notice of an increase in the capital stock of the People's Light and Heat Company from $50,000 to $1,000,000 has been filed with the secretary of state. The notice is in accordance with the announcement that the company is to enlarge its business to such an extent that electrical power generated in Vigo County will supply current for use in Indianapolis and intermediate points. The original articles of incorporation are amended to read that the company's purpose is to supply light, power, heat and water between this city and Terre Haute.

NEWBURGH, N. Y.—The Newburgh Electric Light, Heat and Power Company, has contracted with the Honks Falls Electric Power Company to purchase from the latter a portion of the power produced by its plant at Honks Falls on the Esopus and Rondout Creek near Ellenville. It proposes to erect an additional plant at High Falls, which is expected to develop about the same amount of power as does the Honks Falls plant, to be in operation by the first of next October. A line for the transmission of electricity between High Falls and Newburgh will be completed during the summer and the current thus obtained will be used to supply patrons of the Newburgh Light, Heat and Power Company in that city.

ST. LOUIS, MO.—The cost of city lighting from May 13, 1907, to the same date this year, is stated at $644,885.22 in the annual report submitted to the board of public improvements by Harry S. Sanderson, supervisor of city lighting. Of this amount, $122,111.70 was for electric lighting of streets and alleys down-town. Electric lighting of public buildings cost $21,033.84. This does not include the lighting of the city hall, the old city hall, four courts, police headquarters, No. 6 engine house and court house. Gas lighting of streets and parks outside the underground district cost $501,739.68. The report states that 678.68 miles of street, out of a total of 903.28 miles, are now lighted, while 44.45 miles of alleys, out of a total of 347.02 miles, are illuminated. There are 15,720 gas and gasolene mantles in use in the lighting of the city; 775 incandescent electric lamps and 1,192 electric arc lights.

BUTTE, MONT.—The Butte Electric and Power Company has purchased from the Amalgamated company the Parrott smelter at Parrott, six miles south of Whitehall, and all the rights to the land and the water power controlled by the Amalgamated at that place. The consideration is not named. Already work has been begun on the rehabilitation of the plant. The three turbines which were put in when the smelter was constructed will be repaired and used to develop 1,500 horse-power, and three new turbines will be installed to develop 1,500 additional horse-power. In all, the Butte Electric Company expects to expend $100,000 on the new plant and to be using the power by the first of August. The Butte Electric and Power Company now controls power plants which develop 34,000 horse-power, distributed as follows: Livingston plant, 2,000; Madison plant, 15,000; Big Hole plant, 4,000; Billings plants, formerly the Billings Water Power and the Yellowstone River Power Company, 5,000; steam auxiliaries, 5,000; Parrot plant, 3,000.

NEW PUBLICATION.

BINDERS FOR COAL BRIQUETTES—The United States Geological Survey has published bulletin No. 343, devoted to a study of binders for coal briquettes. This is the result of investigations made at the United States fuel testing plant, St. Louis, Mo., by James E. Mills.

ELECTRIC RAILWAYS.

PENDLETON, ORE.—Engineers have begun surveys for an electric line from Pendleton to Echo.

GARY, IND.—The new electric line, built by the Gary & Interurban Electric Railroad, has been placed in operation.

WASHINGTON, D. C.—The House has renewed the franchise of the Baltimore & Washington Transit Company to extend its tracks into the District of Columbia.

MARSHALLTOWN, IOWA—The city council has declared void the franchise granted a year ago to the Marshalltown Electric Street and Interurban Railway Company.

PORTLAND, ORE.—The city council has granted to the United Railways Company a franchise for its interurban line from Portland to Hillsboro, by way of Mount Calvary Cemetery.

BIRMINGHAM, ALA.—It is announced that work on the Tidewater Development Company's electric line from Gadsden to Tuscaloosa, through Birmingham, will begin within sixty days.

CHARLESTON, S. C.—At a meeting of the Charleston & Summerville Electric Railway it was voted to issue $100,000 additional common stock and preferred stock to the amount of $300,000.

IRWIN, PA.—The council has granted a franchise to the Irwin-Herminie trolley line, work to begin within sixty days and to be completed within a year. The trolley company will pay the town $8,000 for the franchise.

SPRINGFIELD, ILL.—The secretary of state has issued a license to incorporate to the Charleston & Casey Traction Company, with principal office in Charleston, Ill. It is proposed to construct an electric railroad from Charleston, Coles County, to Casey, Clark County.

LONG BEACH, CAL.—It is announced that the Pacific Electric Railway Company will shortly begin work on the completion of its line between Long Beach and Wilmington. The new road will reduce the distance between Long Beach and Wilmington about six miles.

MINNEAPOLIS, MINN.—The contract for the grading of thirty miles of right of way of the Twin City & Lake Superior Railway near Foxboro, south of the state line, has been let by the company's officials in Minneapolis to Roderick Smith, of the firm of Smith & Jones, Duluth.

WYNNEWOOD, OKLA.—The Commercial Club is considering a proposition to raise $20,000 as a bonus to a trolley line that may pass through here from Chickasha to Sulphur. Scott Jones, of Sulphur, is promoter of the road, which proposes to run *via* Lindsay, Pauls Valley, Wynnewood and Davis.

SIOUX CITY, IOWA—One thousand dollars has been raised to pay the expenses of an interurban survey between this city and Council Bluffs and Omaha. F. W. Bisbee, of Castana, is the chief mover in the project. The proposed route passes through a rich territory and a number of thriving towns.

LIMA, OHIO—Local capitalists are projecting a trolley line between this city and the village of Spencerville, paralleling the Erie. If the line is built it is expected it will be extended through to Montpelier, Ind., a good Hoosier terminus, while Marion is an objective point east. Preliminary surveys are being made.

DAYTON, OHIO—The Dayton City Railway Company, which will construct a line extending from Southeast Dayton to Northwest Dayton, has been granted permission to construct tracks on Lehman street, and will build a retaining wall along the Miami River at that point. Active work of construction has been begun in Dayton View.

FULLERTON, CAL.—Work will be begun at once on another arm of the Pacific Electric Railway system, which will reach into La Habra Valley, a fertile section northwest of Fullerton. The Pacific electric will reach this territory by building on from Los Nietos, on the Whittier line, surveys having been made and right of way secured some time ago.

BOSTON, MASS.—The Worcester Consolidated Street Railway Company has petitioned the railroad commission for authority to issue $922,000 bonds, the proceeds to retire floating debt. The commission authorized the company to sell the same amount of stock in 1901 and 1902, but the company has never done so. It also asks authority to issue $2,260,000 bonds to retire funded debt.

OIL CITY, PA.—A trolley line to follow the bank of the Allegheny River, between this city and Warren, is a project that is being fostered by local and Warren capitalists. The line will follow the south side of the stream and run through Tionesta, Hickory, Tidioute and other towns. The distance is about forty-five miles. It will connect with the Warren-Jamestown line, giving direct service from Oil City to Lake Chautauqua.

CHICAGO, ILL.—The property of the Chicago Electric Traction Company, owned by the Chicago & Southern Traction Company, has been conveyed to Hal C. Bangs through James S. Hopkins, a master in chancery in the United States Circuit Court. The consideration was $350,000. The line of the Chicago Electric Traction Company begins at Sixty-third street and Vernon avenue and runs to Harvey, with connections to Blue Island, Chicago Heights and other points.

TERRE HAUTE, IND.—It is announced that contracts for the construction of an interurban line from Kokomo to Terre Haute by way of Frankfort, a distance of 104 miles, soon will be let by the Kokomo, Frankfort & Terre Haute Traction Company and active work of grading and track laying started some time this summer. The proposed route of the line will parallel the Cincinnati & Louisville tracks from Kokomo to Frankfort and the Vandalia Railroad tracks from Frankfort to Terre Haute.

LANCASTER, PA.—M. H. Bochow, representing a Philadelphia syndicate, has secured control of the Lancaster & York Furnace Street Railway Company by purchasing 1,720 shares of the stock from President Fred Shoff. The latter has been succeeded as president by Mr. Bochow, while Charles Heath, Philadelphia, becomes superintendent. The capital stock, $150,000, has been doubled. The road is to be a link in a proposed line connecting Philadelphia and Baltimore.

SPRINGFIELD, OHIO—With a capital stock of $1,000,000, George W. Baker has organized a company to construct and operate the Washington traction line from Springfield to Chillicothe and other points. The incorporators of the Springfield & Washington Railway Company are: George W. Baker, Hiram C. Baker, Charles Baughton, W. E. Roderick, Ulric Sloane and W. W. Keifer. The line will pass through Clark, Madison, Green, Fayette and Ross counties, with headquarters at Washington C. H.

BROOKLYN, N. Y.—The Long Island Railroad Company has begun work on the construction of a six-mile experimental stretch of electric railroad, from Garden City to Island Trees, south of Hicksville, over the central line. The trains of the new line will be operated by means of an overhead trolley, similar in construction to that of the New York, New Haven & Hartford between New York and Stamford, and a few other suburban lines. A single-phase alternating current of high voltage will be employed.

CHICAGO, ILL.—The Northwestern Elevated Railway is adding equipment and transmission machinery which will double the capacity of its new Evanston extension, the expenditures being necessitated by the increased traffic. New machinery has been contracted for with the General Electric Company which will double the capacity of the power station at Calvary Cemetery. When this is in place the output of the station will be increased from approximately 3,000 horse-power to 6,000 horse-power. The company is arranging to spend $100,000 for additional motor equipment.

CHIPPEWA FALLS, WIS.—Interurban connections soon will be made between River View, Stanley and neighboring towns. A dam is being constructed across the Eau Claire River at River View, and it is the purpose to develop enough power to enable the running of the trolley system. The line, as it is planned, will have as terminals Stanley and River View for the present, later taking in or making a link by adding the towns of Fairchild, Augusta and Neillsville. It is proposed to construct and maintain a complete telephone system, connecting these towns, work on the system already having been begun.

PITTSBURG, PA.—The construction of a new trolley road, to be twenty-five miles long and to cost $1,250,000, which, when completed, will leave but a twenty-mile gap from Pittsburg to Mercer

and Sharon, is to be started September 1. About twelve cars will be put into commission. The road is being financed by Mercer men, including L. W. Orr, Senator James Campbell and Frank Filer. The road will be of the same general pattern as the Pittsburg & Butler Street Railway, and will extend from Mercer to Clarksville, and from there to Greenville and Sharon. There is talk of building an electric road over the twenty-mile gap between Butler and Mercer, which would give connection with the Pittsburg Railways system.

ROCHESTER, N. Y.—At a meeting of the stockholders of the Buffalo, Lockport & Rochester Electric Railway Company, held at Niagara Falls, directors and officials were elected. The directors are: John M. Campbell, of Kingston, Ontario; A. C. Douglass, mayor of Niagara Falls; Lorenzo Burrows, and George B. Church, Albion; A. H. Merritt, of Niagara Falls; J. W. Mitchell, J. Fraser, H. F. Nichols and A. Oakley, of Toronto. Mr. Campbell, who is a prominent electrician and has been connected with the road for some time, was elected president. Mr. Campbell, will have his headquarters in Rochester for the present and will direct the work, preparatory to opening the road for operation, from this end. Mr. Oakley, who represents the Toronto interests in the company, is vice-president, secretary and treasurer of the company. The road is now completed between Rochester and Albion, and the stretch from Middleport to Lockport is practically ready.

NEW MANUFACTURING COMPANIES.

DOVER, DEL.—The United Electric Company, of Havana, Cuba, has been incorporated to deal in electrical supplies of all kinds, with a capital of $50,000.

SAN FRANCISCO, CAL.—The Keystone Electrical Company has been incorporated with a capital of $10,000 by S. H. Foster, George Nolan and W. W. Goldnamer.

ALBANY, N. Y.—The Schenectady Manufacturing Company, of Schenectady, to manufacture electrical appliances, etc., has been incorporated with a capital of $24,000.

WILMINGTON, DEL.—The American Railway Appliance Company has been incorporated with a capital of $1,000,000. The incorporators are: F. M. Shive, S. E. Roberson, H. W. Davis, of Wilmington.

RIDGEWOOD, N. J.—The Lawrence Manufacturing Company, of Ridgewood, has been incorporated by P. Bowman Bird, Nat P. Lane and V. O. Lawrence, to manufacture railway and tramway equipments. The capital stock is $25,000.

ALBANY, N. Y.—Articles of incorporation have been filed with the secretary of state by the Troy Telephone Specialty Company, of Troy. The capital is $15,000 and the directors are Perry Fitzgerald, of Albany, and Edward L. Graull and Joseph P. McLaughlin.

ALBANY, N. Y.—The Chautauqua Electric Company, of Jamestown, has been incorporated with a capital of $5,000 to do a general electrical and contracting business. The directors are as follows: Frederick H. Balcom, of Jamestown, and G. B. Barrell and B. J. Shannahan, of Buffalo.

RICHMOND, VA.—A charter has been granted to the Railway Safety Appliance Company, with a capital of from $50,000 to $200,000. The officers are: President W. A. Higgs; vice-president, J. N. Garber; secretary, C. A. Crowell, all of Staunton, Va. The company will manufacture railway safety appliances.

EDUCATIONAL NOTES.

LEWIS INSTITUTE—Lewis Institute, Chicago, Ill., in its bulletin for April, 1908, gives full descriptions of the courses and instruction offered by that institution. Copies may be obtained by addressing Dean George P. Adams, registrar.

CLARKSON SCHOOL OF TECHNOLOGY—The Thomas S. Clarkson Memorial School of Technology, Potsdam, N. Y., held its ninth annual commencement exercises from June 7 to 12. The baccalaureate address was delivered by the Rev. Richard Mitchel Sherman, of Potsdam, on Sunday, June 7, and on Friday addresses were delivered at the commencement exercises by Dr. Henry Taylor Bovey, dean of the Faculty of Applied Science of McGill University, Montreal, and rector of the Imperial College of Science and Technology, London, and William R. Hill, special deputy state engineer of New York. The degree of bachelor of science was conferred upon eleven candidates.

TELEPHONE AND TELEGRAPH.

CUERO, TEX.—A telephone line is to be built from Stratton to Terryville.

HOPKINTON, N. H.—The West Hopkinton Telephone Company is extending its line to Webster.

LOCKESBURG, ARK.—The Lockesburg Telephone Company is making arrangements to construct a line to Paraclifta and Riddle.

GREENFIELD, MASS.—The New England Telephone Company has placed in operation a new common battery system in Greenfield.

WASHINGTON, N. J.—The Hackettstown Telephone line has been extended to Stephensburg, and connection will soon be made with Johnsonburg.

CHELSEA, MASS.—The Chelsea board of aldermen has granted a franchise to the Home Telephone Company. The company is to furnish a $50,000 bond.

KENNETT SQUARE, PA.—Farmers in the vicinity of Kennett Square, dissatisfied with the rates charged by the local telephone company, are arranging to build an independent line.

COOPERSVILLE, MICH.—The Citizens' Telephone Company will erect a telephone exchange building this summer. The local exchange has about 250 subscribers out of 900 inhabitants.

MILES CITY, MONT.—Construction on the Miles City telephone line, forty-four miles in length, will be commenced at once. Seven cars of poles, or 1,800 in all, are here ready for distribution.

SPENCERPORT, N. Y.—The Ogden Telephone Company has under way the erection of an exchange building at Adams Basin. The company expects to complete its system about the first of July.

TREZEVANT, TENN.—At a meeting of the directors of the Trezevant Telephone Company it was decided to build a direct long-distance line from this city to Bradford, thus connecting the two telephone systems. The proposed line will run *via* Holley Leaf.

BERRYVILLE, ARK.—Farmers in Carroll County are planning to build an independent telephone line from Berryville south on the Berryville and Huntsville county road to make connection with Marsh Brothers' independent line to Huntsville. The line will give direct communication with Eureka Springs by way of Huntsville.

KLAMATH FALLS, ORE.—A telephone system for the use of the farmers under the government irrigation ditch has been completed. Twelve telephones in iron cases have been installed along the line of the canal for the use of the farmers in communicating with the operation and maintenance department of the irrigation system.

PHOENIXVILLE, PA.—The farmers of East Vincent have organized a telephone company and will build a telephone system several miles in length. The board of managers is composed of Seneca Mowrey, Francis Bechtel and Solomon Good. Hermann Lotshew is president, and Samuel Baertolet vice-president. Work has already been commenced.

KANSAS CITY, MO.—At a meeting of the directors of the Wyandotte County Telephone Company, in Bonner Springs, Kan., these officers were elected: S. W. Twist, president; J. A. Thompson, vice-president, and J. D. Waters, secretary and treasurer. The company is planning to consolidate all the private exchanges in Wyandotte County. It has $100,000 capital.

CARLETON, MICH.—The stockholders of the People's Telephone Company, of Wayne, at their annual meeting elected the following officers: President, Joseph Waltz, of Waltz; first vice-president, Edward G. Maxwell, of Carleton; second vice-president, Jesse Butler, of Willow; secretary and treasurer, Frank L. Edwards, of Carleton; directors, the officers and Anthony Reiser, of Wayne, and P. J. Butler, of New Boston. It was voted to increase the capital stock of the new company from $6,000 to $12,000 for the purpose of building new lines and extending the service. The company owns about seventy-five miles of lines and 300 telephones.

INDUSTRIAL ITEMS.

THE NOVELTY INCANDESCENT LAMP COMPANY, Emporium, Pa., is distributing a very attractive calendar card for June.

THE CAMPBELL-STAGG COMPANY, New York city, has been organized as eastern sales representative, with headquarters at 220 Broadway. The partnership consists of William G. Campbell and De Peyster Stagg.

THE MANHATTAN ELECTRICAL SUPPLY COMPANY, 17 Park Place, New York city, has ready for distribution its trade discount sheet applying to catalogue No. 21. This list supersedes all previous quotations, and is dated April 16.

THE STANDARD ROLLER BEARING COMPANY, Philadelphia, Pa., announces the recent installation at its factory of a thoroughly equipped testing laboratory in charge of Walter H. Hart, an expert chemist, formerly connected with the Alan Wood Iron and Steel Company.

THE R. D. NUTTALL COMPANY, Pittsburg, Pa., announces that it has added to its already comprehensive list of gears and pinions the well-known "Titan" brand of manganese steel gears and pinions, having arranged with the Atha Steel Casting Company for their exclusive sale.

THE H. W. JOHNS-MANVILLE COMPANY, 100 William street, New York city, announces the opening of a branch office at 30 Pennsylvania street, Indianapolis, Ind., under the management of Charles E. Wehr, who for several years has represented the company in that territory.

THE EXCEL ELECTRIC HEATING COMPANY, 54 Vesey street, New York city, has ready for distribution a bulletin describing its iron-clad, indestructible, interchangeable electric heating devices. This is applied to travelers' irons, domestic irons, heavy-duty irons and disc stoves.

THE RAILWAY SPECIALTY AND SUPPLY COMPANY, Great Northern Building, Chicago, Ill., has ready for distribution some interesting literature devoted to Paine's vise grip rail anchor, and the "P. & M." rail anchor. Copies of this literature will be furnished to those interested upon request.

THE AMERICAN CARBON AND BATTERY COMPANY, East St. Louis, Ill., has published two very interesting pamphlets, entitled, respectively, "Brush History" and "Do You Know?" These pamphlets are replete with valuable information concerning carbon brushes for street railway and central station purposes. Copies will be furnished upon request.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., in the June issue of "Graphite" publishes some very interesting information concerning the use of graphite in power-station work. One of the interesting illustrations is that of the Dixon booth at the New York Pure Food Show, and another illustration shows the Dixon booth at the Boston Automobile Show.

THE BAY STATE LAMP COMPANY, Danvers, Mass., has equipped a plant for the manufacture of "Hygrade" new lamps, which it will sell in addition to the Bay State incandescent lamp. The efforts of this company to make a really high-grade carbon-filament lamp have already met with considerable success. The company has an office at 136 Liberty street, New York city.

THE ELECTRIC GOODS MANUFACTURING COMPANY, Boston, Mass., announces that the sale of its jobbing department to the Western Electric Company does not include its factory nor the products of the same. The company will continue to manufacture the "Samson" battery, annunciators, telephones, electric bells, etc., and is about to place on the market a number of new specialties.

THE CUTLER-HAMMER MANUFACTURING COMPANY, Milwaukee, Wis., has issued a sixteen-page pamphlet descriptive of its "Wirt" type dynamo brush, designed for use with low-tension, direct-current motors and generators, alternating-current generators, plating dynamos, exciters, etc. The construction of the brush is fully described and illustrated in this pamphlet. Copies will be furnished on request.

THE F. BISSELL COMPANY, Toledo, Ohio, has installed a department of illumination. This department will be in charge of R. W. Hiett, illuminating engineer. It will be the object of the department to give information as to proper distribution of lighting units so as to secure the best illumination both as to quality and cost. The company will be pleased to have any one submit plans for a lighting layout or request information of this department.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., has published a very handsome booklet entitled "Works and Products." This shows pictorially and with considerable text the great range of power apparatus which is manufactured by the Allis-Chalmers Company. The booklet will be sent to any one interested upon request. The Allis-Chalmers Company has also issued bulletin No. 1429, containing a detailed description of jaw crushers and their adaptability.

THE BENJAMIN ELECTRIC MANUFACTURING COMPANY, Chicago, Ill., is placing on the market a new device in the form of an adjustable plug socket, the principal use of which is that of an adapter for tungsten lamps. It is provided with a rotating sleeve which permits a complete revolution of the socket, together with a hinge joint, securing almost any angle of adjustment desired. The position of lamps in a fixture or bracket may thus be changed to any position. Where the lamps are desired to be turned at right angles with a horizontal socket or receptacle a second device is furnished.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., is distributing another series of attractive literature devoted to several different lines of apparatus. A new booklet describes and illustrates electrically heated household appliances. This is devoted to flatirons, water heaters, combination cookers, tea-kettles, percolators, chafing dishes, stoves, frying pans, grids and broilers, ovens, corn-poppers, cooking and baking outfits, cigar lighters, heating pads, shaving cups, glue pots, luminous radiators and tubular air heaters. Among the new bulletins now being distributed are the following: No. 4,586, devoted to the G. I. flame arc lamp; No. 4,588, the GE-202 railway motor; No. 4,594, tungsten economy diffusers; No. 4,595, GE aluminum lightning arresters for alternating-current circuits, form I.

THE CHICAGO FUSE WIRE AND MANUFACTURING COMPANY, 170 South Clinton street, Chicago, Ill., has published catalogue No. 21, devoted to "Union" switch boxes, outlet boxes and covers. The "Union" stamped steel switch boxes, outlet boxes and covers for rigid conduit, metallic armored cable and flexible conduit meet every requirement of the electrical contractor. The sectional gang feature of "Union" switch boxes is one that immediately appeals to all users. The two-gang box can be built up into any desired number of gangs by the aid of spacers. The work can be done on the job, considerably reducing the cost of installation. The outlet boxes are drawn from No. 14 Brown & Sharpe gauge steel, having conduit outlets which are effectively closed with knockouts that can be easily removed with a single blow of the hammer.

DATES AHEAD.

Canadian Electrical Association. Annual meeting, Toronto, Ontario, June 17-19.

Society for the Promotion of Engineering Education. Annual meeting, Detroit, Mich., June 22-27.

American Society of Mechanical Engineers. Semiannual meeting, Detroit, Mich., June 23-26.

American Society of Civil Engineers. Annual meeting, Denver, Col., June 23-26.

Association of Railway Telegraph Superintendents. Annual meeting, Montreal, Quebec, June 24-26.

American Institute of Electrical Engineers. Annual convention, Atlantic City, N. J., June 29-July 2.

Street Railway Association of the State of New York. Annual meeting, Niagara Falls, N. Y., June 30-July 1.

National Electrical Contractors' Association. Next meeting, Chicago, Ill., July 15-17.

Michigan Electric Association. Annual meeting, Grand Rapids, Mich., August 18-21.

International Association of Municipal Electricians. Annual convention, Detroit, Mich., August 19-21.

American Society of Municipal Improvements. Annual meeting, Atlantic City, N. J., October.

Illuminating Engineering Society. Annual convention, Philadelphia, Pa., October 6-7.

Directory of Electrical and Allied Engineering and Scientific Societies.

(Published in the Second Issue of Each Month.)

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. Secretary, L. O. Howard, Cosmos Club, Washington, D. C.

AMERICAN ELECTROTHERAPEUTIC ASSOCIATION. Secretary, Dr. Albert C. Geyser, 352 Willis avenue, New York city.

AMERICAN ELECTROCHEMICAL SOCIETY. Secretary, Dr. J. W. Richards, Bethlehem, Pa.

AMERICAN FOUNDRYMEN'S ASSOCIATION. Secretary, Dr. Richard Moldenke, Watchung, N. J.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Secretary, Ralph W. Pope, Engineering Societies Building, 29 West Thirty-ninth street, New York city. Meetings, second Friday of each month. Annual convention, Atlantic City, N. J., June 29-July 2.

AMERICAN MATHEMATICAL SOCIETY. Secretary, F. N. Cole, 50 West 116th street, New York city.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION. Secretary, J. W. Taylor, Old Colony Building, Chicago, Ill.

AMERICAN ROENTGEN RAY SOCIETY. Secretary, Dr. G. C. Johnson, 514 Bijou Building, Pittsburg, Pa.

AMERICAN SOCIETY FOR TESTING MATERIALS. Secretary, Professor Edgar Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Secretary, Charles Warren Hunt, 220 West Fifty-seventh street, New York city. Annual meeting, Denver, Col., June 23-26.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Secretary, Calvin W. Rice, 29 West Thirty-ninth street, New York city. Spring meeting, Detroit, Mich., June 23-26.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS. Secretary, G. W. Tillson, Park Row Building, New York city. Annual meeting, Atlantic City, N. J., October.

AMERICAN STREET AND INTERURBAN RAILWAY ASSOCIATION. Secretary, B. V. Swenson, Engineering Societies Building, 29 West Thirty-ninth street, New York city.

AMERICAN STREET AND INTERURBAN RAILWAY ACCOUNTANTS' ASSOCIATION. Secretary, Elmer M. White, treasurer Birmingham Railway, Light and Power Company, Birmingham, Ala.

AMERICAN STREET AND INTERURBAN RAILWAY CLAIM AGENTS' ASSOCIATION. Secretary, B. B. Davis, claim agent Columbus Railway and Light Company, Columbus, Ohio.

AMERICAN STREET AND INTERURBAN RAILWAY ENGINEERING ASSOCIATION. Secretary, J. W. Corning, electrical engineer Boston Elevated Railway Company, Boston, Mass.

AMERICAN STREET AND INTERURBAN RAILWAY MANUFACTURERS' ASSOCIATION. Secretary, George B. Keegan, 2321 Park Row Building, New York city.

ARKANSAS INDEPENDENT TELEPHONE ASSOCIATION. Secretary, Charles F. Speed, Texarkana, Ark.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES. Secretary, W. W. Freeman, vice-president and general manager Edison Electric Illuminating Company, Brooklyn, N. Y.

ASSOCIATION OF ELECTRIC LIGHTING ENGINEERS OF NEW ENGLAND. Secretary, Welles E. Holmes, 308 Washington street, Newton, Mass.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS. Secretary, P. W. Drew, Wisconsin Central Railway, Milwaukee, Wis. Annual meeting, Montreal, Quebec, June 24-26.

CALIFORNIA ELECTRIC RAILWAY ASSOCIATION. Secretary, L. E. W. Pioda, Oak and Broderick streets, San Francisco, Cal.

CALIFORNIA INDEPENDENT TELEPHONE ASSOCIATION. Secretary, P. T. Whittier, Spencer, Cal.

CANADIAN ELECTRICAL ASSOCIATION. Secretary, T. S. Young, Toronto, Canada. Annual meeting, Toronto, Ontario, June 17-19.

CANADIAN STREET RAILWAY ASSOCIATION. Secretary, Acton Burrows, 33 Melinda street, Toronto, Ontario.

CENTRAL ELECTRIC RAILWAY ASSOCIATION. Secretary, W. F. Milholland, secretary and treasurer Indianapolis Traction and Terminal Company, Indianapolis, Ind.

COLORADO ELECTRIC LIGHT, POWER AND RAILWAY ASSOCIATION. Secretary, J. F. Dostal, Denver, Col.

CONNECTICUT STATE STREET RAILWAY ASSOCIATION. Secretary, F. W. Poole, Bridgeport, Ct.

ELECTRIC CLUB OF CLEVELAND. Secretary, George L. Crosby, 1200 Schofield Building, Cleveland, Ohio.

ELECTRICAL CONTRACTORS' ASSOCIATION OF NEW YORK STATE. Secretary, John P. Faure, 77 Water street, Ossining, N. Y.

ELECTRICAL CONTRACTORS' ASSOCIATION OF STATE OF MISSOURI. Secretary, Charles J. Sutter, 1220 Pine street, St. Louis, Mo.

ELECTRICAL TRADES ASSOCIATION OF CHICAGO. Secretary, Frederic P. Vose, Marquette Building, Chicago.

ELECTRICAL TRADES ASSOCIATION OF PHILADELPHIA. Secretary, E. A. Symmes, 810 Drexel Building, Philadelphia, Pa. Meetings, second and fourth Thursdays of each month.

ELECTRICAL TRADES ASSOCIATION OF CANADA, LIMITED. Secretary, William R. Stanley, Royal Insurance Building, Montreal, Canada.

ELECTRICAL TRADES ASSOCIATION OF THE PACIFIC COAST. Secretary, Albert H. Elliott, Claus Spreckles Building, San Francisco, Cal. Monthly meetings, San Francisco, first Thursday of each month.

ELECTRICAL TRADES SOCIETY OF NEW YORK (Member National Electrical Trades Association). Secretary, Franz Neilson, 80 Wall street, New York city. Board of directors meets second Friday of each month.

EMPIRE STATE GAS AND ELECTRIC ASSOCIATION. Secretary, Charles H. B. Chapin, 154 Nassau street, New York city.

ENGINE BUILDERS' ASSOCIATION OF THE UNITED STATES. Secretary, J. I. Lyle, 39 Cortlandt street, New York city.

ILLINOIS INDEPENDENT TELEPHONE ASSOCIATION. Secretary, C. A. Camp, of Henry.

ILLINOIS STATE ELECTRICAL ASSOCIATION. Secretary, H. E. Chubbuck, La Salle, Ill.

ILLUMINATING ENGINEERING SOCIETY. Secretary, Van Rensselaer Lansingh, Engineering Societies Building, 33 West Thirty-ninth street, New York city. Annual convention, Philadelphia, Pa., October 6-7.

INDEPENDENT TELEPHONE ASSOCIATION OF TEXAS AND LOUISIANA. Secretary, C. A. Shock, Sherman, Tex.

INDIANA ELECTRIC RAILWAY ASSOCIATION. Secretary, P. H. White, Indianapolis, Ind. Monthly meetings, second Tuesday of each month.

INDIANA INDEPENDENT TELEPHONE ASSOCIATION. Secretary, C. S. Norton, Indianapolis, Ind.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Secretary, Frank P. Foster, Corning, N. Y. Annual meeting, Detroit, Mich., August 19-21.

INTERNATIONAL INDEPENDENT TELEPHONE ASSOCIATION. Secretary, J. B. Ward, Grand Rapids, Mich.; assistant secretary, J. A. Harney, Monadnock Building, Chicago, Ill.

IOWA ELECTRICAL ASSOCIATION. Secretary, W. N. Keiser, Des Moines, Iowa.

IOWA INDEPENDENT TELEPHONE ASSOCIATION. Secretary, C. C. Deering, Boone, Iowa.

IOWA STREET AND INTERURBAN RAILWAY ASSOCIATION. Secretary, L. D. Mathes, Dubuque, Iowa.

KANSAS GAS, WATER, ELECTRIC LIGHT AND STREET RAILWAY ASSOCIATION. Secretary, James D. Nicholson, Newton, Kan.

KENTUCKY INDEPENDENT TELEPHONE ASSOCIATION. Secretary, W. G. Turpine, Henderson, Ky.

MAINE INDEPENDENT TELEPHONE ASSOCIATION. Secretary, M. E. Crow, Houlton, Me.

MAINE STREET RAILWAY ASSOCIATION. Secretary, E. A. Newman, 471 Congress street, Portland, Me.

MASSACHUSETTS STREET RAILWAY ASSOCIATION. Secretary, Charles S. Clark, 70 Kilby street, Boston, Mass. Meets second Wednesday of each month, except July and August.

MASTER CAR BUILDERS' ASSOCIATION. Secretary, J. W. Taylor, 390 Old Colony Building, Chicago, Ill.

MICHIGAN ELECTRIC ASSOCIATION. Secretary, A. C. Marshal, Port Huron, Mich. Annual meeting, Grand Rapids, Mich., August 18-21.

MICHIGAN INDEPENDENT TELEPHONE ASSOCIATION. Secretary, A. A. Burch, Battle Creek, Mich.

MISSOURI ELECTRIC LIGHT, GAS AND STREET RAILWAY ASSOCIATION. Secretary, Claude L. Clary, Sikeston Electric Light and Power Company, Sikeston, Mo.

MISSOURI INDEPENDENT TELEPHONE ASSOCIATION. Secretary, George W. Schweer, Windsor, Mo.

NATIONAL ARM, PIN AND BRACKET ASSOCIATION. Secretary, J. B. Magers, Madison, Ind.

NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION OF THE UNITED STATES. Secretary, W. H. Morton, 94 Genesee street, Utica, N. Y. Next meeting, Chicago, Ill., July 15-17.

NATIONAL ELECTRICAL TRADES ASSOCIATION. Secretary, Frederic P. Vose, 1343 Marquette Building, Chicago.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Secretary, John F. Gilchrist, Commonwealth Edison Company, Chicago, Ill.

NEBRASKA ELECTRICAL ASSOCIATION. Secretary, William Bradford, Lincoln.

NEBRASKA INDEPENDENT TELEPHONE ASSOCIATION. Secretary, R. E. Mattison, Lincoln, Neb.

NEW ENGLAND ELECTRICAL TRADES ASSOCIATION. Secretary, Alton F. Tupper, 60 State street, Boston, Mass.

NEW ENGLAND STREET RAILWAY CLUB. Secretary, John J. Lane, 12 Pearl street, Boston, Mass. Meetings held on fourth Thursday of every month.

NEW YORK ELECTRICAL SOCIETY. Secretary, G. H. Guy, Engineering Societies Building, 29 West Thirty-ninth street, New York city. Annual meeting, Hotel Astor, June 17.

NEW YORK STATE INDEPENDENT TELEPHONE ASSOCIATION. Secretary, R. Max Eaton, Niagara Falls, N. Y.

NORTHWESTERN ELECTRICAL ASSOCIATION. Secretary, R. N. Kimball, Kenosha, Wis.

OHIO ELECTRIC LIGHT ASSOCIATION. Secretary, D. L. Gaskill, Greenville, Ohio.

OHIO INDEPENDENT TELEPHONE ASSOCIATION. Secretary, O. O. Welsheimer, Columbus, Ohio.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS. Secretary, F. W. Ballard, Cleveland, Ohio.

OHIO STREET RAILWAY ASSOCIATION. Secretary, Charles Currie, Akron, Ohio.

OKLAHOMA ELECTRIC LIGHT, RAILWAY AND GAS ASSOCIATION. Secretary, Galen Crow, Guthrie, Okla.

OLD TIME TELEGRAPHERS' AND HISTORICAL ASSOCIATION. Secretary, John Brant, 195 Broadway, New York city.

ORDER OF THE REJUVENATED SONS OF JOVE. C. B. Roulet, Mercury, Dallas, Tex.

PACIFIC COAST ELECTRIC TRANSMISSION ASSOCIATION. Secretary, Samuel G. Reed, Portland, Ore.

PENNSYLVANIA STATE INDEPENDENT TELEPHONE ASSOCIATION. Secretary, H. E. Bradley, 135 South Second street, Philadelphia, Pa.

PENNSYLVANIA STATE STREET RAILWAY ASSOCIATION. Secretary, Charles H. Smith, Lebanon, Pa.

PIKES PEAK POLYTECHNIC SOCIETY. Secretary, E. A. Sawyer, Colorado Springs, Col. Meetings, second Saturday of each month.

RAILWAY SIGNAL ASSOCIATION. Secretary, C. C. Rosenberg, Bethlehem, Pa.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION. Secretary, Arthur L. Williston, Pratt Institute, Brooklyn, N. Y. Annual meeting, Detroit, Mich., June 22-27.

SOUTH DAKOTA INDEPENDENT TELEPHONE ASSOCIATION. Secretary-treasurer, E. R. Buck, Hudson, S. D.

SOUTHWESTERN ELECTRICAL AND GAS ASSOCIATION. Secretary, J. A. Myler.

STREET RAILWAY ASSOCIATION OF THE STATE OF NEW YORK. Secretary, J. H. Pardee, J. G. White & Company, New York, N. Y. Annual convention, Niagara Falls, N. Y., June 30-July 1.

TEXAS INDEPENDENT TELEPHONE ASSOCIATION. Secretary, Charles F. Speed, Texarkana, Tex.

UNDERWRITERS' NATIONAL ELECTRIC ASSOCIATION. Secretary Electrical Committee, C. M. Goddard, 55 Kilby street, Boston, Mass.

VERMONT AND NEW HAMPSHIRE INDEPENDENT TELEPHONE ASSOCIATION. Secretary-treasurer, G. W. Buzzell, St. Johnsbury, Vt.

VERMONT ELECTRICAL ASSOCIATION. Secretary, C. C. Wells, Middlebury Electric Light Company, Middlebury, Vt.

VIRGINIA STATE INDEPENDENT TELEPHONE ASSOCIATION. Secretary, B. L. Fisher, Rocky Mount, Va.

WESTERN ASSOCIATION OF ELECTRICAL INSPECTORS. Secretary, W. S. Boyd, 382 Ohio street, Chicago, Ill.

WESTERN SOCIETY OF ENGINEERS (Electrical Section). Secretary, J. H. Warder, 1737 Monadnock Block, Chicago, Ill.

WISCONSIN ELECTRIC AND INTERURBAN RAILWAY ASSOCIATION. Secretary, Clement C. Smith, president Columbia Construction Company, Milwaukee, Wis.

WISCONSIN INDEPENDENT TELEPHONE ASSOCIATION. Secretary, J. C. Crowley, Jr., Superior, Wis.

Record of Electrical Patents.

Week of June 2.

889,200. ELECTRICAL FUSE. Albert G. Charters and John G. Jones, Watford, England. A rotatable insulator carrying a plurality of fuses.

889,205. RAILWAY SIGNAL SYSTEM. Emory P. Cook, Oberlin, Pa. A block-signaling system provided with an engine circuit including signals which are actuated upon the failure of the main signal.

889,220. TROLLEY POLE. John C. Gay, Jordanville, N. Y. A pole formed of two parallel hinged rods.

889,264. TROLLEY CATCHER AND RETRIEVER. Robert Shields, South Boston, Mass., assignor to Frank Ridlon Company, Boston, Mass. A spring-actuated retriever.

889,266. THIRD-RAIL ATTACHMENT FOR ELECTRIC CARS. George H. Sohn, Lincoln, Cal. The contact rail is supported between two protecting members.

889,277. ELECTRIC RAILWAY. Casimir Von Gizinsky and William McClure, Schenectady, N. Y. A safety third-rail system, electrical contact being made by pressing down the flexible upper surface.

889,288. INSULATED RAIL JOINT. Benjamin Wolhaupter, New York, N. Y., assignor to the Rail Joint Company, New York, N. Y. The angle bar has a plate for supporting by one rail end.

889,305. REVERSING TIMER AND DISTRIBUTER. John O. Heinze, Jr., Lowell, Mass. A distributor for gas engine igniters.

889,317. MAGNET FOR TELEGRAPHONES. John A. Lieb, New York, N. Y., assignor to American Telegraphone Company. The surface of the magnet pole is provided with a wear-resistive device.

889,322. LAMP RECEPTACLE. Andrew A. Moffitt, Providence, R. I. A cup of non-conducting material is used for preventing short-circuits.

889,338. IGNITER. George J. Schultz, New York, N. Y., assignor to Benjamin Briscoe, Tarrytown, N. Y. A spark plug with a plurality of spark-gaps.

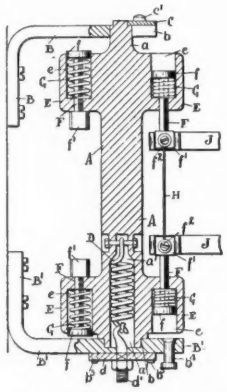
889,346. EYE MAGNET. Harold Thomassen, Dayton, Ohio. A bipolar magnet with curved ends for producing an intense local magnetic field.

889,355. THERMOSTAT. Peabody A. Brown, Denver, Col. Increased movement of the contacts is secured by causing both to move through the expansion of the thermostat.

889,358. CUTOUT MECHANISM FOR ELECTRICALLY OPERATED MACHINES. George S. Conger and Charles Pearce, New York, N. Y., assignors to Eltypic Manufacturing Company, New York, N. Y. A device for maintaining the actuating current during short intervals in the use of the machine and for stopping the current during long intervals.

889,431. FURNACE FOR METALLURGICAL AND SMELTING PURPOSES. Kristian Birkeland, Lysaker, near Christiania, and Samuel Eyde, Christiania, Norway. An arc furnace with a varying magnetic deflecting field for swinging the arc across the hearth.

889,432. SPARK PLUG. George J. Blum, Chicago, Ill., assignor to Armstrong-Blum Manufacturing Company, Chicago, Ill. Contact is made and broken electromagnetically.



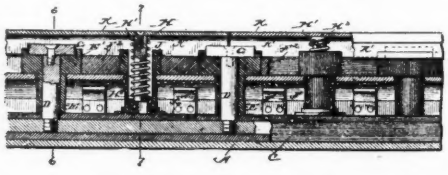
889,200.—ELECTRICAL FUSE.

889,448. THIRD-RAIL ELECTRIC-RAILWAY SYSTEM. John F. Feeley, Bigtimber, Mont. A suspended, shielded third rail.

889,463. TROLLEY WHEEL. Robert F. Henne, Mamaroneck, N. Y. The wheel is allowed axial movement.

889,482. ELECTRIC SIGNALING SYSTEM. Francis L. O'Bryan, South Framington, Mass., assignor of one-half to Hiram Stanley Marsh, Cambridge, Mass. The track signals are operated by motors.

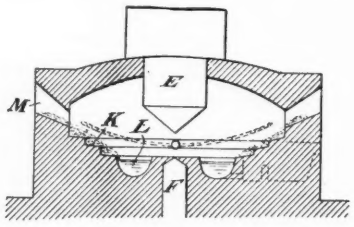
889,522. ELECTRIC INDUCTION FURNACE. Karl A. F. Hiorth, Christiania, Norway. The hearth has a spiral form, metallic contact being provided between the two ends.



889,277.—ELECTRIC RAILWAY.

889,533. ILLUMINATING ELECTRIC CLOCK AND CALL SYSTEM. George B. Maas, Cleveland, Ohio. A clock for distributing time signals.

889,559. PROTECTOR FOR THIRD RAILS OF RAILWAY SYSTEMS. Joseph N. Tomlinson, Vineland, N. J. Shoes of insulating material are fitted over the rail, leaving the top surface for contact.



889,431.—FURNACE FOR METALLURGICAL AND SMELTING PURPOSES.

889,561. SIGNAL SYSTEM FOR RAILWAYS. Louis H. Thullen, Edgewood, Pa., assignor to the Union Switch and Signal Company, Swissvale, Pa. A difference of potential is maintained between adjacent blocks for actuating the signals.

889,566. ELECTRIC SWITCH. Alfred A. Wohlauer, New York, N. Y. A mercury switch.

889,567. SYSTEM OF ELECTRICAL DISTRIBUTION. Joseph L. Woodbridge, Philadelphia, Pa. An alternating-current direct-current system with transforming apparatus.

889,582. TELEPHONE SYSTEM. Henry P. Clausen, Chicago, Ill., assignor to American Electric Telephone Company, Chicago, Ill. A central battery system.

889,592. TELEGRAPH SYSTEM. Stephen D. Field, Stockbridge, Mass. A local inductive shunt is provided at each station, bridged directly across the key.

889,608. LAMP HANGER. William R. Holcomb, U. S. Army, assignor of one-half to John S. Jones, Jefferson Barracks, Mo. An adjustable cord suspension.

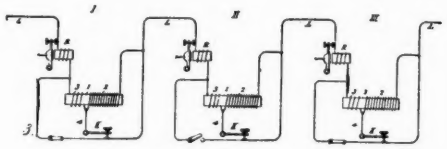
889,659. ELECTRICALLY OPERATED PHOTOGRAPHIC APPARATUS. William A. Chamberlain, Sunbury, Pa. The shutter and regulating valve are operated by an electromagnet.

889,715. TROLLEY. Earl D. Peerstone, Chicago, Ill. The harp is provided with two or more wheels.

889,765. THERMAL ELECTRIC ALARM. Lloyd Currier, Underwood, N. D. A thermostatic contact maker.

889,776. TROLLEY WIRE SPLICER. Harry G. Dyer, Gloucester City, N. J., assignor of one-half to William J. Van Meter, Gloucester City, N. J. A tapered splice with locking keys.

889,784. TELEGRAPH SYSTEM. Charles K. Jones, Quincy, Ill., assignor, by mesne assignments, of thirty one-hundredths to Railway Telegraph Automatic Signal Company. An electromagnet for closing circuits is controlled by a relay.



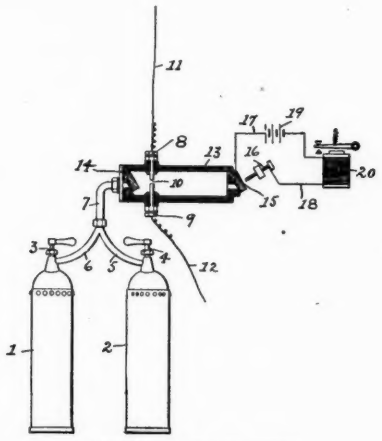
889,592.—TELEGRAPH SYSTEM.

889,786. CONNECTOR FOR ELECTRIC WIRES. Charles J. G. Keiner, Baltimore, Md., assignor to Universal Railway Supply Company. The fuse is enclosed in two intermeshing insulating coverings.

889,789. TELEGRAPHY. Isidor Kitsee, Philadelphia, Pa. The make and break circuit is operated by exploding a gaseous mixture.

889,790. TELEGRAPHY. Isidor Kitsee, Philadelphia, Pa. The make and break contact is operated by the heating effect of an electric arc on gas.

889,791. WIRELESS TELEGRAPHY. Isidor Kitsee, Philadelphia, Pa. Preheated gas is exploded by a spark, impulses thus produced operating the make and break contact.



889,789.—TELEGRAPHY.

889,792. TELEGRAPHY. Isidor Kitsee, Philadelphia, Pa. A detector for electric waves formed of metallic plates, one side of each being oxidized.

889,803. SUPPORT FOR ELECTRICAL CONDUCTORS. Francis B. H. Paine, Buffalo, N. Y., assignor to Niagara, Lockport and Ontario Power Company. Two insulators are employed, one supporting the line wire and the other a contact device for indicating the failure of the first.

889,841. DYNAMOELECTRIC MACHINE. Vincent G. Apple, Dayton, Ohio, assignor to Dayton Electrical Manufacturing Company. Poles fitted with attenuated faces of paramagnetic metal.

889,857. ELECTRIC FURNACE. Albert J. Petersson, Alby, Sweden. An arc furnace with magnetic blowout for oxidizing gases.

889,884. INSULATOR. M. Harrison Strong, Ozark, Mo., assignor of one-half to Solomon E. Bronson, Ozark, Mo. An insulator built up of strips and two reel-shaped insulating parts.